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VOL. XXXIX. No. 3.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE
EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ,
BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM
OCTOBER, 1904, to MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT,
U. S. N., COMMANDING.

XXXII.

ASTEROIDEA.

By HUBERT LYMAN CLARK.

WITH SIX PLATES.

[Published by Permission of H. M. SMITH, U. S. Commissioner of Fish and Fisheries].

CAMBRIDGE, U. S. A.:
Printed for the Museum.

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EASTERN TROPICAL PACIFIC ASTEROIDEA.

INTRODUCTION.

THE collections of sea-stars made by the ALBATROSS on her Tropical Pacific expeditions were not large, but as they contained much valuable material from deep water they were entrusted to Prof. Hubert Ludwig, by whom the report on the Panamic collection of 1891 was prepared. The collection made in 1899-1900 contained but forty-two specimens of thirteen species, of which ten were well-known littoral forms while three were deep-sea species, new to science; these thirteen species are included in the Memoir on the Panamic starfishes which was published in 1905 (*Mem. M. C. Z.*, 32). The collection made in 1904-05 was much larger and Ludwig never completed his work on it. In 1907 (*Zool. Anz.*, 31, p. 312-319) he published a preliminary description of five new species and a new variety of *Porcellanasteridae*, but his study of the other families was unfinished at the time of his death in 1913. Later the collection was sent to Cambridge together with his notes, some of which were apparently in form for publication. It was at first thought that these notes would be of service in the preparation of the present report, but it soon became evident that the correlation between the notes and the collection was too imperfect to permit this. There are notes on species, including descriptions of new forms, which are not in the collection as returned to Cambridge and there are many species in the collection not mentioned in the notes. Under the circumstances therefore, I have decided to base this report exclusively on the collection as returned to Cambridge.

The collection at present consists of 235 specimens of twenty-eight species and one variety, but 148 of the specimens represent three species and four additional species total fifty specimens. Three fourths of the species therefore are represented on an average by fewer than two specimens each. Of the twenty-eight species, six are littoral and twenty-two are deep-water forms. Of the littoral species, five are common and long-known species, while one is of exceptional interest, being a new asteriid from Easter Island. Of the deep-water species, eight are as yet undescribed forms while five others were new to science when the collection was sent to Ludwig; these (as already stated) have been

named and described by him. Of the other nine species, all but one were taken by the ALBATROSS Expedition of 1891.

Half of the deep-water species described as new belong to the Brisingidae, while a fifth member of the family, in this collection, was hitherto known only from the Atlantic Ocean. These facts illustrate well how characteristic of the deep-water fauna the Brisingidae are and how little that fauna is as yet known. It is worthy of note that of the more than a dozen species of Brisingidae now known from the Pacific, not one is in the present collection.

With the increasing knowledge of the deep-sea fauna, several genera of sea-stars have been enlarged by numerous species until it is by no means easy to determine the various forms assigned to them. I have therefore attempted the revision of Hymenaster and Zoroaster. As the latter genus includes the bulk of the Zoroasteridae, the revision is extended to include the other genera and species thereof. Artificial keys to the species which seem entitled to recognition are included. Complete lists of the species proposed up to the present time, in these genera, with the necessary bibliographical references, are also given.

SYSTEMATIC ACCOUNT.

PORCELLANASTERIDAE.

Eremicaster pacificus.

Porcellanaster pacificus LUDWIG, 1905. Mem. M. C. Z., **32**, p. 89.

Eremicaster pacificus FISHER, 1907. Zool. Anz., **32**, p. 14.

These specimens, in which R = 15 and 22 mm., are not peculiar in any way, but agree well with the original material from the Panamic region. I fully agree with Fisher, in dissent from Ludwig, that the number of cribriform organs is a more important, and also a more available, generic character than the presence or absence of the segmental papillae. The bathymetrical range is considerably increased by the present record and the geographical range is extended to the south about 300 miles.

Station 4647. Eastern Tropical Pacific, 4° 33' S., 87° 42' 30" W., 2,005 fms. Bott. temp. 35.5°. Lt. gy. and br. glob. oz.

Station 4649. Eastern Tropical Pacific, 5° 17' S., 85° 19' 30" W., 2,235 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Two specimens.

Eremicaster tenebrarius.

Porcellanaster (Eremicaster) tenebrarius FISHER, 1905 (10 June). Bull. U. S. Bur. Fish., **24**, p. 293.

Porcellanaster waltharii LUDWIG, 1905 (July). Mem. M. C. Z., **32**, p. 92.

Eremicaster tenebrarius LUDWIG, 1907. Zool. Anz., **31**, p. 318.

This species has been so well-described and figured by Fisher (1911. Bull. 76 U. S. N. M., p. 24-29), and its variations so fully discussed, that nothing of importance can be added. There seems to be no doubt of the identity of *waltharii* and *tenebrarius*. The present series is of interest only because the largest (R = 45 mm.) is somewhat larger than Fisher's specimens and because of the range extension. The bathymetrical range is extended nearly 600 fathoms while the geographical range is extended southward almost 800 miles.

Station 4647. Eastern Tropical Pacific, 4° 33' S., 87° 42' 30'' W., 2,005 fms. Bott. temp. 35.5°. Lt. gy. and br. glob. oz.

Station 4658. Eastern Tropical Pacific, 8° 30' S., 85° 35' 36'' W., 2,370 fms. Bott. temp. 35.3°. Fne. gn. m., mang. nod.

Station 4666. Eastern Tropical Pacific, 11° 55' 30'' S., 84° 20' 18'' W., 2,600 fms. Bott. temp. 34.9°. Lt. gy. oz.

Station 4672. Peru: southwest of Palominos Light House, 88 miles, 2,845 fms. Bott. temp. 35.2°. Fne. dk. br. infus. m.

Station 4717. Eastern Tropical Pacific, 5° 11' S., 98° 56' W., 2,153 fms. Bott. temp. 35.2°. Rd. c., glob. oz.

Twenty-four specimens.

Eremicaster vicinus.

Plate 2, fig. 7, 8.

Porcellanaster vicinus LUDWIG, 1907. Zool. Anz., **31**, p. 318.

Eremicaster vicinus FISHER, 1907. Zool. Anz., **32**, p. 14.

Although Ludwig's description is very brief, it gives all the essential characters of this species and a detailed account now seems quite superfluous. There is a good series of specimens, ranging from 19 to 32 mm. in diameter and showing little diversity in structure, save in the armature of the superomarginal plates; in three specimens (one from 4670 and the only two individuals from 4672), there are no spines on the superomarginals and these are the ones Ludwig has called "var. *inermis*." One specimen has the terminal third of a ray curiously doubled; seen from above, the abnormal width and the two terminal plates, coalesced along their inner margins, are striking; on the lower surface there are two distinct ambulacral furrows, each with six or seven pairs of tube-feet.

Fisher (1911. Bull. 76 U. S. N. M., p. 30) says that "*vicinus* is insecurely separated from *pacificus*" but I do not think he would feel so if he had compared specimens. Besides the absence of actinal interradiial spinelets, *vicinus* has two characteristics which easily separate it from *pacificus*. One of these is found in the adambulacral spines, which are very small (short and slender) and are placed close together at the adoral end of the plate, while the other and more conspicuous is in the spinulation of the oral plates, which have only one, or

sometimes two minute conical spinelets near the center of the margin, instead of 2-5 large, flat spines occupying practically the entire margin. While the abactinal surface of *vicinus* is thus indistinguishable, by any constant character, from that of *pacificus*, the oral surface is separable at a glance.

Station 4670. Peru: west of Palominos Light House, 105 miles, 3,209 fms. Bott. temp. 35.4°. Fne. dk. br. m.

Station 4672. Peru: southwest of Palominos Light House, 88 miles, 2,845 fms. Bott. temp. 35.2°. Fne. dk. br. infus. m.

Forty-six specimens.

Ctenodiscus crispatus.

Asterias crispata RETZIUS, 1805. Diss. Ast., p. 17.

Ctenodiscus crispatus DÜBEN AND KOREN, 1846. K. Vet. Akad. Handl. f. 1844, p. 256.

So fully has this well-known species been discussed by earlier writers and particularly by Fisher (1911, Bull. 76 U. S. N. M., p. 31-37), it would be quite superfluous to give space to its diversities here. The series at hand is a large one but from only a single station, and the specimens range in diameter from 15 to 70 mm.

Station 4631. Panama: off Mariato Point, 72 miles, 774 fms. Bott. temp. 38°. Gn. s.

Thoracaster magnus.

Plate 1, fig. 1, 2.

LUDWIG, 1907. Zool. Anz. 31, p. 313.

This truly superb species has been sufficiently described by Ludwig, who has also pointed out some of the characteristic differences between it and the genotype, which was taken by the CHALLENGER in the Atlantic in 2,400 fms. Since Ludwig described *magnus*, Koehler has published an account of a third species of the genus, *alberti*, taken by the INVESTIGATOR in the Indian Ocean in 1,504 fms. But *alberti* is obviously different in many particulars from either of the other species, so that the genus contains three very well-marked forms.

The cribriform organs of *magnus* tend to merge together to a very marked degree, and apparently this is a matter of age. For in a specimen with R = 23 mm., these organs are quite distinct and although the three middle pairs are very broad, much wider than the interspaces which separate them, they do not merge at all; the outer pair are so narrow and inconspicuous, one would scarcely consider them cribriform organs. On the other hand in a specimen with R = 73 mm., all fourteen of the organs are more or less merged together; those near the interradius are merged for practically their full height, being

separated by only an insignificant bare elevation on the upper edge of the superomarginal plate, and by a similar low knob about twice as large on the lower edge of the inferomarginals; distally these knobs become gradually longer and more conspicuous, though not noticeably higher, and finally, between the sixth and seventh organs on each side, they permit the merging of the organs only along the line between the upper and lower marginal plates. In large specimens, the low elevations on the inferomarginals bear scattered, small spinelets of diverse sizes.

In another particular, *magnus* differs markedly from the other two species of the genus, and that is in the series of abactinal plates which extends to the tip of the arm or nearly so. In a specimen with $R = 23$ mm. this series is .60 mm. wide clear to the terminal plate; the plates composing it are of irregular size and form and show no definite arrangement; they are largest distally (but not close to the terminal plate where they are very small) and some of them may be fully .60 mm. across; the larger plates and even the smaller distal ones bear no spinelets but have a smooth, slightly convex surface. In a large specimen, with $R = 73$ mm., the plates do not reach the extreme tip of the arm, but are shut off from the terminal plate by the meeting of three pairs of superomarginals; the plates are more angular and flatter than in the smaller specimen and their surface is somewhat coarsely shagreened; there is a very abrupt transition from the small spinelet-bearing plates of the disk to the bare median series of the arm; this occurs about 35 mm. from the arm-tip.

The disk and cribriform organs are yellow-brown in the preserved specimens, with all the marginal plates, bare plates of arms and whole lower surface more or less nearly white. In size the range is from $R = 23$ to $R = 98$ mm.

Station 4647. Eastern Tropical Pacific, $4^{\circ} 33' S.$, $87^{\circ} 42' 30'' W.$, 2,005 fms. Bott. temp. 35.5° . Lt. gy. and br. glob. oz.

Station 4649. Eastern Tropical Pacific, $5^{\circ} 17' S.$, $85^{\circ} 19' 30'' W.$, 2,235 fms. Bott. temp. 35.4° . Fne. stky. gy. m.

Station 4658. Eastern Tropical Pacific, $8^{\circ} 30' S.$, $85^{\circ} 36' W.$, 2,370 fms. Bott. temp. 35.3° . Fne. gn. m., mang. nod.

Station 4717. Eastern Tropical Pacific, $5^{\circ} 11' S.$, $98^{\circ} 56' W.$, 2,153 fms. Bott. temp. 35.2° . Rd. e., glob. oz.

Nine specimens.

Styracaster monacanthus.

Plate 2, fig. 1, 2.

LUDWIG, 1907. Zool. Anz., **31**, p. 315.

While the original description of this unique specimen is adequate, Ludwig does not discuss its relationship to other members of the genus, although he

himself describes four new species in his relatively brief paper. But the omission is not serious for the present species is notably distinct and might well be made the type of a new genus. It resembles *S. chuni* and *S. paucispinus* in the large disk and short arms; the general facies is thus very different from that of the typical members of *Styracaster*. But the absence of paxillae and the presence of only five narrow cribriform organs distinguishes *monacanthus* at once from its two nearest allies and these differences are accentuated by the very low and wide interrational marginal plates and the presence of only a single spine on the supramarginal series of plates of each arm. The low, rounded scale-like spines on the margin of the oral plates are an added feature worthy of note. The disk is light gray and the arms and marginal plates are nearly white, in slight contrast.

Station 4701. Eastern Tropical Pacific, 19° 11' 30'' S., 102° 24' W., 2,265 fms. Bott. temp. 35.5°. Dk. br. choc. c., mang. nod.

One specimen.

***Styracaster paucispinus*.**

Plate 2, fig. 3, 4.

LUDWIG, 1907. Zool. Anz., 31, p. 315.

Ludwig's description of this species is somewhat more ample than that of *monacanthus* but as in the case of that species, he does not discuss its relationships. It agrees with *S. armatus*, *spinusus*, and *edwardsi* in the possession of only three cribriform organs in each interbranchial are; in the great breadth of these, *paucispinus* is nearest to *armatus*. But it differs very markedly from all these species, in its very short arms, R equalling 2.5 r or less, whereas in the three other species, R = 3 r or more. Associated with this shortness of arms is a reduction in the number of superomarginal spines which are never more than three to an arm and may be one only; Ludwig says "two or three" but I fail to find more than two in any case; the longest ones are scarcely 2 mm. high and are quite thick at the base. The "winzigen, granuloiden stachelchen" on the ventrolateral plates are so minute as to hardly warrant the name, and in one specimen appear to be quite wanting. The adambulacral plates have a marked depression or shallow furrow on the ventral surface; this runs from the inner adoral corner of the plate, where it is deepest, to the outer aboral corner, where it flattens out entirely.

There is little color left in these specimens, which are nearly white, only the disk and the cribriform organs being more or less brownish.

Station 4658. Eastern Tropical Pacific, 8° 30' S., 85° 35' 36'' W., 2,370 fms. Bott. temp. 35.3°. Fne. gn. m., mang. nod.

Two specimens.

Albatrossia nuda.

Plate 2, fig. 5, 6.

Albatrossaster nudus LUDWIG, 1907. Zool. Anz., **31**, p. 318.

The very small starfish upon which this species is based is unquestionably congeneric with the two somewhat larger specimens upon which *A. semimarginalis* was founded by Ludwig, but the reduction of the inferomarginal plates has not gone so far, and since the disk is almost completely bare of spines, it is probably best to consider the present specimen representative of a different species. But Ludwig's proposed change of the generic name from *Albatrossia* to *Albatrossaster* is quite unjustifiable for *Albatrossia* is a different word from *Albatrossa* with which Ludwig feared it might be confused. The confusion does not seem probable, but in any case, the International Commission on Nomenclature fully settled the matter in their Opinion 25 (July, 1910), dealing with the identical case of *Damesella* vs. *Damesiella*. *Albatrossaster* must therefore be considered as a synonym of *Albatrossia*.

The holotype of *A. nuda* is very well-preserved, save for the breakage or loss of the large spines on the terminal plate. $R = 7$ mm. and $r = 4.5$. The terminal plate is 1 mm. long and 2 mm. broad, with a deeply concave proximal margin; it carries three spinelets, nearly or quite a millimeter long, one at the middle of the upper margin and one at each of the lower distal corners. The cribriform organ is more than a millimeter wide and the anal tube is nearly a millimeter long. The adambulacral armature consists of two flat, wide, pointed spinelets, subequal or the distal one larger. Two similar spinelets occur on the free lateral margins of the much swollen and conspicuous oral plates; at the inner end of these plates, situated on the suture between them is a single, large, oral spine. Ventrolateral plates, like disk, smooth and without spinelets. Color of disk pale dull reddish; marginal plates nearly white; lower surface tinged with dull reddish.

Station 4647. Eastern Tropical Pacific, 4° 33' S., 87° 42' 30'' W., 2,005 fms. Bott. temp. 35.5°. Lt. gy. and br. glob. oz.

One specimen.

ASTROPECTINIDAE.

Dytaster demonstrans.

LUDWIG, 1905. Mem. M. C. Z., **32**, p. 41.

There is a good series of this species, both young (R = 10–25 mm.) and adults (R up to 110 mm.) but Ludwig's very full account, with its numerous figures, leaves no occasion for extended notice. While I agree with Fisher that *demonstrans* is probably identical with *gilberti*, I have not seen specimens of the latter and therefore leave the point for future settlement. The following stations extend the range of *demonstrans* some 500 miles southward, and bathymetrically 150 fms.

Station 4647. Eastern Tropical Pacific, 4° 33' S., 87° 42' 30'' W., 2,005 fms. Bott. temp. 35.5°. Lt. gy. and br. glob. oz.

Station 4649. Eastern Tropical Pacific, 5° 17' S., 85° 19' 30'' W., 2,235 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Station 4656. Eastern Tropical Pacific, 6° 54' 36'' S., 83° 34' 18'' W., 2,222 fms. Bott. temp. 35.2°. Fne. gn. m., mang. nod.

Station 4658. Eastern Tropical Pacific, 8° 30' S., 85° 35' 36'' W., 2,370 fms. Bott. temp. 35.3°. Fne. gn. m., mang. nod.

Eighteen specimens.

BENTHOPECTINIDAE.

Pectinaster agassizii.

Cheiraster agassizii LUDWIG, 1905. Mem. M. C. Z., **32**, p. 1.

Pectinaster agassizii LUDWIG, 1910. Sitz. K. Preuss. Akad. Wiss., **23**, p. 449.

These specimens are in rather poor condition and none have the arms unbroken but R ranges from about 40 to 80 mm. Some specimens have a few small pedicellariae on the abactinal surface close to the superomarginal plates at the base of the rays but there are no intermarginal pedicellariae. These specimens, while still *agassizii*, show some approach to Fisher's subspecies *P. a. evoplus* from farther north. The exact locality where they were taken is not certain, but it was probably at

Station 4631. Panama: off Mariato Point, 72 miles, 774 fms. Bott. temp. 38°. Gn. s.

Eleven specimens.

GONIASTERIDAE.

Pseudarchaster pectinifer.

LUDWIG, 1905. Mem. M. C. Z., **32**, p. 106.

These specimens, with R = 60 and 80 mm. respectively, are somewhat intermediate between that originally described by Ludwig and the one discussed

by me in 1913 (Bull. Amer. Mus. Nat. Hist., 32, p. 192). The number of adambulacrals in proportion to *ten* inferomarginals is either nine or ten, while the number of adambulacral spines is from six to eight, and there are from five to eight spines on the ventral surface of the plate. On the other hand the projecting angle of the adambulacrals is not near the aboral end of the plate, but in the larger specimen is about at the middle and in the smaller is distinctly adoral. Probably these details of the adambulacral plates show considerable diversity in the species.

The armature of the superomarginal plates in the present specimens somewhat resembles that of *P. dissonus* for from four to eight of the granules on the outer (lower) end of the superomarginals in the interbrachial arc are more or less elongated into flattened, bluntly pointed spinelets. But these spinelets do not seem to be encased in "membranous sheaths" nor are they as long as in typical *dissonus*.

Station 4654. Peru: off Aguja Point, 24 miles, 1,036 fms. Bott. temp. 37.3°. Dk. br. m.

Two specimens.

Litonotaster tumidus,¹ sp. nov.

Plate 3, fig. 3-6.

R = 28 mm.; r = 14 mm.; R = 2 r. Disk pentagonal, the arms arising quite abruptly from the angles. Br. = 6 mm. at base and nearly 2 mm. just before tip. In some specimens, the body is not noticeably pentagonal, the interbrachial arcs being very well-rounded. Thus in a specimen with R = 27 mm., r = 11.5 mm. and br., at the level of the interbrachial arcs, 11 mm., the form is quite evenly stellate. In all cases however, the disk is more or less swollen; in the holotype, the vertical diameter at center of disk is 11 mm. while at the margin the thickness is only 3.5 mm.

Abactinal surface covered by numerous circular or rounded-polygonal, thin plates, .5-1 mm. in diameter, not very firmly united together and hence forming a flexible covering. In each interradius but one, is a circular plate, evidently larger than its neighbors, about 1.3 mm. across; in the fifth interradius is the madreporite, a somewhat tumid, rounded-triangular plate, 1.5 mm. across, adjoined on each of its three sides by a plate about 1 mm. wide and .75 mm. high. Excepting the madreporite, these interradiar plates are discernible only in dry specimens. In each radius, at the base of the arm, is a group of

¹ *tumidus* = swollen, in reference to the flexible, puffed upper surface of disk.

4-12 plates, noticeably larger than the others, and among these are the only papulae to be found, but even these are small and inconspicuous. All the abactinal plates are surrounded by a series of small rounded granules; on the disk, the surface of each plate also carries several (3-15) similar granules; these may be crowded but are usually rather well-spaced. On the arms, the granules on the surface of the plates become few and disappear, so that at the tips of the arms, the plates entirely lack them, only the marginal series being present there.

Marginal plates 15 on each side of each ray, or 16 in the inferomarginal series; the plates in the two series are of about equal size or the inferomarginals are somewhat larger than the superomarginals in the interbrachial arc and somewhat smaller at the very tip of the ray. Distally each plate is surrounded by a marginal series of small granules, like those of the abactinal plates, while the surface of the plate is bare, but as one passes towards the interradius, granules appear on the surface and in the interbrachial arc pretty well cover the plates; those on the inferomarginals are larger than those on the upper series and are quite angular and more or less pointed. Terminal plate slightly tumid, smooth, transversely oval, not conspicuous.

Actinolateral plates squarish or polygonal not arranged in very definite series, except one row adjacent to the adambulacrals; the plates of this row are the largest and proximally are more than a millimeter square. They extend out two thirds the length of the arm, beyond which the adambulacrals abut directly on the inferomarginals. All the actinolateral plates are moderately well-covered with spaced, pointed spinelets, considerably larger than the granules of the abactinal surface. Adambulacral plates squarish, proximally about equal to the adjoining actinolaterals but becoming larger (relatively only, of course) at middle of arm. Each plate bears a marginal series of five or usually four subequal, slightly tapered blunt spines, about a millimeter long; immediately external to this marginal series, the surface of the plate is bare, but along the outer margin are 4-8 pointed granules or low spinelets similar to those of the actinolateral plates, but perhaps a little larger; these are arranged in one or often two distinct series. Oral plates large but not very tumid; each carries a marginal series of 10-12 spines similar to those of the adambulacral plates, except that the one at the tip of plate (proximally) is noticeably stouter than the others; on the surface of the plate are 10-14 low spinelets like those of the actinolateral plates but a little larger.

Pedicellariae are exceedingly rare but on each specimen critically examined, one was found; this was composed of two wide, blunt, erect valves, slightly

wider at tip than basally; it occurred on the surface of an adambulacral plate near the middle of the arm. In the smallest specimen, half a dozen of these pedicellariae were found on the actinolateral plates.

Color, in alcohol, light yellow-brown, which dries out to a dingy whitish.

Station 4656. Eastern Tropical Pacific, 6° 54' 36" S., 83° 34' 18" W., 2,222 fms. Bott. temp. 35.2°. Fne. gn. m., mang. nod.

Station 4672. Peru; southwest of Palominos Light House, 88 miles, 2,845 fms. Bott. temp. 35.2°. Fne. dk. br. infus. m.

Twelve specimens.

The holotype is from Station 4672.

The discovery of a second species of *Litonotaster* is one of the interesting results of the work of the ALBATROSS in the Tropical Pacific, for the genus was hitherto known from only the deep waters of the West Indies, Koehler having shown (1909. INVESTIGATOR Ast., p. 73) that Alcock's (1893. Ann. Mag. Nat. Hist., (6), 11, p. 90) identification of an Indian starfish as identical with the West Indian form was quite erroneous. The genus seems to be a very well-marked one and the present species shows its distinctive characters perfectly. But the differences between *tumidus* and *intermedius*, the genotype, are obvious, particularly in the three following points:— in *tumidus* the abactinal plates of the ray extend clear to the terminal plate while in *intermedius* this is not the case, the distal superomarginals meeting in the radial line; in *tumidus*, the abactinal plates of the distal part of the ray are more uniformly bare than in *intermedius*; and finally, there are only four or five adambulacral spines in *tumidus* as against seven or eight in *intermedius*.

The present species does not show a great deal of individual diversity except in the body-form, already referred to, which is due to the amount of flattening of the interbrachial are. The only growth-change noted is the greater granulation of the abactinal plates in the adult. In the smallest specimens (R = 19 mm.) most of the disk-plates and those on the proximal part of the arms, as well as the distal plates on the arms, lack granules on the surface, only the marginal series being present. The madreporite is relatively, as well as actually, very much smaller in the small specimens than in the larger.

OREASTERIDAE.

Nidorellia armata.

Pentaceros (Nidorellia) armatus GRAY, 1840. Ann. Mag. Nat. Hist., **6**, p. 277.

Nidorellia armata VERRILL, 1867. Trans. Conn. Acad., **1**, p. 280.

A single specimen with $R = 85$ mm. was brought back from Chatham Island, Galapagos.

LINCKIIDAE.

Linckia guildingii.

GRAY, 1840. Ann. Mag. Nat. Hist., **6**, p. 285.

A small "comet-form" Linckia, with the main arm 25 mm. long, and the four small arms 8–10 mm., taken at Papeete, Tahiti, seems to be the young of this species.

Pharia pyramidata.

Ophidiaster (Pharia) pyramidatus GRAY, 1840. Ann. Mag. Nat. Hist., **6**, p. 284.

Pharia pyramidata SLADEN, 1889. Challenger Ast., p. 784.

There are three specimens of this common Panamic species from Perico Island, Panama. They are remarkable for the short, stumpy appearance of the arms, which are only about four times as long as thick. $R = 90$ – 95 mm.; br. = 23 mm. Closer examination shows that not a single arm has a normal tip but in every case the distal part is missing. Although the injury has healed in each case there is no true regeneration started on any arm. It would be interesting to know whether some fish is a persistent browser on this sea-star at Perico Island.

ECHINASTERIDAE.

Henricia gracilis.

Cribrella gracilis LUDWIG, 1905. Mem. M. C. Z., **32**, p. 204.

Henricia gracilis FISHER, 1911. Bull. 76 U. S. N. M., p. 270.

Two very small Henricias ($R = 10$ mm.) are as near to this species as to any and are best regarded as young specimens thereof, particularly since one of the original examples of *gracilis* was taken near the Galapagos Islands in 384 fms.

Station 4642. Galapagos Islands: Hood Island, 4 miles southeast of Ripple Point, 300 fms. Bott. temp. 48.6° . Brk. sh., glob.

PTERASTERIDAE.

Although there are only two specimens of this family in the collection, their identification has necessitated a critical revision of the genus *Hymenaster* and it has seemed worth while to publish this revision. The first reference to the group in literature occurs in Wyville Thomson's *The Depths of the Sea*, published in 1873, but it was really the work of the CHALLENGER, in the same and three subsequent years, which revealed what a wide-spread and characteristic deep-sea genus *Hymenaster* is. Since that day numerous additional species have been taken, until the number which have been named now reaches a total of forty-four. The following list gives these species in their chronological order with the necessary bibliographical references and the locality and depth at which they were first taken.

List of the specific names used with Hymenaster.

- pellucidus* WYVILLE THOMSON, 1873. *Depths of the Sea*, p. 120. Faerøe Channel, 580 fms.
nobilis WYVILLE THOMSON, 1876. *Journ. Linn. Soc. Zool.*, **13**, p. 73. 1,099 miles southwest of Australia, 1,800 fms.
membranaceus WYVILLE THOMSON, 1877. *The Atlantic*, **1**, p. 108.¹ Off Portugal, 1,125 fms.
formosus SLADEN, 1882. *Journ. Linn. Soc. Zool.*, **16**, p. 213. 1,099 miles southwest of Australia, 1,800 fms.
pergametaceus SLADEN, 1882. *Ibid.*, p. 215. East of Buenos Ayres, 2,650 fms.
sacculatus SLADEN, 1882. *Ibid.*, p. 217. 1,099 miles southwest of Australia, 1,800 fms.
echinulatus SLADEN, 1882. *Ibid.*, p. 218. Mid-South Pacific, 2,335 fms.
carnosus SLADEN, 1882. *Ibid.*, p. 220. Off Chili, 1,500 fms.
glaucaus SLADEN, 1882. *Ibid.*, p. 221. Southwest of Suruga Gulf, Japan, 565 fms.
vicarius SLADEN, 1882. *Ibid.*, p. 223. Between Juan Fernandez and Valparaiso, 1,375 fms.
infernalis SLADEN, 1882. *Ibid.*, p. 224. Mid-North Pacific, 2,900 fms.
caelatus SLADEN, 1882. *Ibid.*, p. 225. 1,099 miles southwest of Australia, 1,800 fms.
crucifer SLADEN, 1882. *Ibid.*, p. 227. 1,099 miles southwest of Australia, 1,800 fms.
anomalus SLADEN, 1882. *Ibid.*, p. 228. North of Tristan da Cunha, 1,425 fms.
latebrosus SLADEN, 1882. *Ibid.*, p. 230. Southwest of Australia, 1,950 fms.
parosissimus SLADEN, 1882. *Ibid.*, p. 231. Between Juan Fernandez and Valparaiso, 1,375 fms.
graniferus SLADEN, 1882. *Ibid.*, p. 233. Between Marion and Crozet Islands, 1,375 fms.
geometricus SLADEN, 1882. *Ibid.*, p. 234. Mid-South Pacific, 2,335 fms.
pullatus SLADEN, 1882. *Ibid.*, p. 235. Southwest of Admiralty Islands, 1,070 fms.
coccinatus SLADEN, 1882. *Ibid.*, p. 238. Between Marion and Crozet Islands, 1,375 fms.
praecoquis SLADEN, 1882. *Ibid.*, p. 240.² Near Crozet Islands, 1,375-1,600 fms.
modestus VERRILL, 1885. *Amer. Journ. Sci. ser. 3*, **29**, p. 151.³ Off southern New England, 1,098-1,451 fms.

¹ It is perhaps debatable whether there is an adequate description in connection with this first use of the name, but as the points mentioned would probably distinguish the species from the only other *Hymenasters* known at the time, it may be just as well to let the name continue to rest on Wyville Thomson's authority.

² These eighteen species described by Sladen, as well as the three named by Wyville Thomson, are fully illustrated in Sladen's *Challenger Asteroidea*, issued in 1889.

³ It is doubtful whether this description is adequate. A much better one appeared in 1894, *Proc. U. S. N. M.*, **17**, p. 277.

- giganteus* SLADEN, 1891. Proc. Roy. Irish Acad., ser. 3, **1**, p. 696. Southwest of Ireland, 750 fms.
giboryi PERRIER, 1894. Travailleur et Talisman Stell., p. 189. Between Azores and Europe, 2,218 fms.
rex PERRIER, 1894. *Ibid.*, p. 186.¹ Eastern North Atlantic, 623–1,248 fms.
regalis VERRILL, 1895. Amer. Journ. Sci. ser. 3, **49**, p. 203. Off southern New England, 1,374 fms.
regalis var. *agassizii* VERRILL, 1899. Trans. Conn. Acad., **10**, p. 221. Off southern New England, 1,242 fms.
perspicuus LUDWIG, 1903. Belgica Seesterne, p. 30. Antarctic Ocean, southwest of Alexander the First Land, 222–250 fms.
quadriscopinosus FISHER, 1905. Bull. U. S. Bur. Fish., **24**, p. 315. Off San Diego, Cal., 1,059 fms.
platyacanthus LUDWIG, 1905. Mem. M. C. Z., **32**, p. 191. Panamic region, 1,359–1,572 fms.
purpureus LUDWIG, 1905. *Ibid.*, p. 194. Between Cocos Island, and Panama, 1,470 fms.
violaceus LUDWIG, 1905. *Ibid.*, p. 196. Southeast from Acapulco, Mexico, 1,877 fms.
gracilis LUDWIG, 1905. *Ibid.*, p. 198. Panamic region, 1,321–1,771 fms.
pentagonalis FISHER, 1906. Hawaiian Starfishes, p. 1099. Hawaiian Islands, 289–334 fms.
roseus KOEHLER, 1907. Bull. Inst. Ocean., no. 99, p. 21. Eastern North Atlantic, 1,009–1,148 fms.
campanulatus KOEHLER, 1908. Trans. Roy. Soc. Edinburgh, **46**, p. 550. Weddell Sea, 1,410 fms.
densus KOEHLER, 1908. *Ibid.*, p. 554. Weddell Sea, 2,620 fms.
edax KOEHLER, 1908. *Ibid.*, p. 552. East of South Orkney Islands, 1,775 fms.
fuscatus KOEHLER, 1908. *Ibid.*, p. 553.² Weddell Sea, 1,410 fms.
alcocki KOEHLER, 1909. Investigator Deep Sea Ast., p. 110. East side, Bay of Bengal, 643 fms.
koehleri FISHER, 1910. Ann. Mag. Nat. Hist., ser. 8, **5**, p. 170. Bering Sea, 1,771 fms.
perissonotus FISHER, 1910. *Ibid.*, p. 170. Off San Diego, California, 984 fms.
bartschi FISHER, 1916. Proc. Biol. Soc. Washington, **29**, p. 29. Sulu Sea, 1,105 fms.
rhodopeplus FISHER, 1916. *Ibid.*, p. 29. Gulf of Tomini, Celebes, 834 fms.

The form which Verrill described as a variety (*agassizii*) of *regalis* seems undoubtedly a valid species as it differs from *regalis* in several fundamental points.

The characters which seem of the most importance in distinguishing the species of *Hymenaster* are the armature of the oral plates and of the adambulacral plates. In most species the number of adambulacral spines, of oral spines, and of suboral spines is remarkably constant. In a few cases, we find three adambulacral spines where the typical number is two, or four where three is usual, and if the number of oral spines is three, there may occasionally be four, while if the number is usually four or five it may run up to seven. The number and form of the suborals is less liable to diversity, but owing to slight shifts of position or some diversity in size, it is often difficult to decide whether the spine nearest the inner end of the oral plate is a suboral or the innermost oral. Careful consideration of its relation to the other orals will generally determine the point however. Thus in *carnosus*, Sladen says there are two suborals but admits that the inner is perhaps an oral; his figure shows that it is best considered the innermost oral. In *quadriscopinosus* Fisher, it is possible, as that author

¹ These two species of Perrier were named and the names were published in 1885 but with no description or figures; the names therefore must date from 1894.

² These four species of Koehler were mentioned and named in 1907, Zool. Anz., **32**, p. 144, but as the diagnoses are wanting or wholly inadequate, the names must date from the full report. The *Hymenaster scotiae* of the 1909 Zoological Record is a slip of the pen for *Hyphalaster scotiae*.

says, that the innermost oral should be considered a suboral but I have not the material to determine the point. In using the following key to the species of *Hymenaster*, these possible variations in number of adambulacral, oral, and suboral spines must be kept in mind and when there is any doubt both alternatives should be followed out. The key includes not only all the species listed above, but also the two new forms described below, each of which has some very distinctive characters. Of course the accumulation of more material will bring out defects in the present key, but it will serve as a beginning for a satisfactory brief expression of the taxonomy of the genus. It will be noticed that some of the characters which were considered of primary importance by Sladen, such as the reticulation of the supradorsal membrane, and the body-form, are here either ignored entirely or relegated to a very subordinate position. This has been done because these characters vary so much with the condition of the specimen, as to be of doubtful value. Most *Hymenasters* are secured only by dredging or trawling in very deep water and they reach the surface in a more or less contracted, contorted, and often damaged condition. It is therefore often impossible to determine what the form and appearance in life were. Since the calcareous parts are less likely to be altered by capture and preservation, I have sought to use these as far as possible in distinguishing the species. Probably this leads to a more artificial arrangement than if *all* the characters could be considered but under existing conditions any arrangement of the species of so little-known a genus must be more or less non-phylogenetic.

Key to the species of Hymenaster.

- A. Adambulacral armature of one spine.
 - B. Suboral spine single.
 - C. Oral spines 2.....*cremnodes*.
 - CC. Oral spines 3 or 4.
 - D. Spiracula not in definite circumscribed areas, except for regular transverse bands on interbrachial membrane; oral spines nearly as long as jaws.....*nobilis*.
 - DD. Spiracula in definite circumscribed areas but transverse bands on interbrachial membrane replaced by small, detached, scattered areas; oral spines about half as long as jaw or less.....*koehleri*.
 - BB. Suboral spines 2 on each plate.
 - C.¹ Oral spines 2.....*formosus*.
 - CC.¹ Oral spines 3 or 4.
 - D.¹ Actinolateral membrane thin with very long actinolateral spines; spiracula very small in widely scattered groups of 6-10.....*pergamentaceus*.
 - DD.¹ Actinolateral membrane thick with short or moderately long actinolateral spines buried in it; spiracula moderately large in irregular groups of usually more than 10.
 - E. Suboral spines acicular.....*rhodopeplus*.
 - EE. Suboral spines thick, stout, sacculate.....*violaceus*.
- AA. Adambulacral armature of more than one spine.

- B.¹ No true suboral spines though the innermost of the 3 orals might be so considered. *trias*.
- BB.¹ Suboral spines present.
- C.² No small marginal spines on oral plates.
- D.² 3 large, subequal spines on each oral plate (all suborals or 2 suborals + 1 oral). *edax*.
- DD.² 2 large spines on each oral plate (both suborals or 1 suboral + 1 oral).
- E.¹ Valves of osculum with 5 or 6 spines; paxillae with 5-8 spinelets; color yellowish white.
campanulatus.
- EE.¹ Valves of osculum with 10 spines; paxillae with 4 spinelets; color dark or at least dusky.
purpureus.
- CC.² Marginal spines (orals), smaller than suborals, present on oral plates.
- D.³ Suboral spine single.
- E.² Adambulacral spines 2; membranes fleshy; spiracula very small and grouped; orals 4-6.
- F. Suboral spine like a segmental papilla. *pentagonalis*.
- FF. Suboral spine not like a segmental papilla. *carnosus*.
- EE.² Adambulacral spines more than 2.
- F.¹ Rays attenuate, R = about 2 r; adambulacral spines 3. *geometricus*.
- FF.¹ Rays not at all attenuate.
- G. Orals 3, stout; third or fourth actinolateral spine longest. *coccinatus*.
- GG. Orals 4 or 5, slender.
- H. Fifth or sixth actinolateral spine longest; adambulacral spines 3 or 4, not in a continuous series. *modestus*.
- HH. Seventh to eleventh actinolateral spines longest; adambulacral spines 4 or 5 in a continuous series. *quadrispinosus*.
- DD.³ More than one suboral to a plate.
- E.³ Suboral spines 2 on each plate.
- F.² Only 2 adambulacral spines (3 on some plates, in *perissonotus*).
- G.¹ Only 2 orals. *giboryi*.
- GG.¹ 3 or more orals.
- H.¹ Paxillar spinelets few, rarely more than 5, often 3.
- I. Orals 3.
- J. Actinolateral spines rather short, robust, eighth or ninth longest. *echinulatus*.
- JJ. Actinolateral spines very long, twentieth to twenty-second longest.
giganteus.
- II. Orals 4-7.
- J.¹ Of actinolateral spines, fifth to twelfth longest.
- K. More or less pentagonal; paxillar spinelets 4 or 5; orals 4. *roseus*.
- KK. More or less stellate; paxillar spinelets usually 3; orals 5. *agassizii*.
- JJ.¹ Of actinolateral spines, twelfth to twenty-first longest.
- K.¹ Of actinolateral spines, twentieth or twenty-first longest. *sacculatus*.
- KK.¹ Of actinolateral spines, eighteenth or earlier longest.
- L. Paxillar areas of rays conspicuously elevated; actinolateral spines short, stout. *glaucus*.
- LL. Paxillar areas not conspicuously elevated; actinolateral spines long, slender.
- M. Paxillar spinelets 3 or 4; on some plates, 3 adambulacral spines.
perissonotus.
- MM. Paxillar spinelets 4-6; only 2 adambulacral spines. *vicarius*.
- HH.¹ Paxillar spinelets many, 5-12.
- I.¹ Paxillar spinelets 5-7. *pellucidus*.
- II.¹ Paxillar spinelets 8-12.
- J.² Form pentagonal. *perspicuus*.
- JJ.² Form stellate. *infernalis*.
- FF.² More than 2 adambulacral spines, except on individual plates or near tip of ray.
- G.² Color deep purple, with fibrous bands in supradorsal membrane and tips of tube-feet, white; adambulacral spines 3, short, thick subequal. *pullatus*.¹
- GG.² Not as above.
- H.² Orals 2; paxillar spinelets 5-7; adambulacral spinelets 3-5; fifth actinolateral spine longest. *praccoquis*.

¹ Sladen's figure shows 4 oral spines but in his description he distinctly says there are only two.

- III.² Orals 3-5.
 I.² Paxillar spinelets 4-7; valves of osculum with 15 spines; actinolateral spines 18, with eighth or ninth longest; adambulacral spines usually 3, the innermost smallest, but sometimes 4, the 2 inner smallest.....*gracilis*.
 II.² Not as above.
 J.³ Adambulacral spines 3.
 K.² Orals only 3.
 L.¹ Valves of osculum duplicated by a smaller external series.....*alcocki*.
 LL.¹ Valves of osculum not duplicated.
 M.¹ Paxillar spinelets 4 or 5.
 N. Paxillar crowns forming raised areas and sharply defining the rays.
 caelatus.
 NN. Paxillar crowns not forming raised areas and not defining rays clearly.....*latebrosus*.
 MM.¹ Only 1 well-developed paxillar spinelet.....*regalis*.
 KK.² Orals more than 3.
 L.² Suborals short and wide (or thick).
 M.² Adambulacral spines very unequal; supradorsal membrane with numerous minute granules.....*graniferus*.
 MM.² Adambulacral spines subequal; supradorsal membrane without granules.....*membranaceus*.
 LL.² Suborals more or less elongate and tapering.
 M.³ Adambulacral spines very unequal; rays conspicuously defined dorsally.....*rex*.
 MM.³ Adambulacral spines subequal.
 N.¹ Tenth to seventeenth actinolateral spine longest.
 O. Inner (proximal) pair of suborals the longest.
 P. Orals 4 subequal; outer suboral stouter than inner, shorter but not greatly so.....*bartschi*.
 PP. Orals 5, the two inner ones much larger; outer suboral much smaller in every way than inner.....*porosissimus*.
 OO. Outer (distal) pair of suborals much the longest.....*crucifer*.
 NN.¹ Sixth actinolateral spine longest; suborals subequal.....*fucatus*.
 JJ.³ Adambulacral spines 4.
 K.³ Paxillar spinelets 3-5; orals 4.....*platyacanthus*.
 KK.³ Paxillar spinelets 5-6; orals 3.....*densus*.
 EE.³ Suboral spines 3 on each plate.....*anomalus*.

Hymenaster cremnodes,¹ sp. nov.

Plate 4, fig. 1.

Rays 5. R = 27 mm.; r = 24 mm.; R = 1.125 r. In its present contracted bell-shape, the specimen is nearly 27 mm. high and about 18 mm. in diameter at the mouth of the bell. Paxillae in three series along each ray with an additional partial row along each side of base of ray. Paxillar spinelets 5 or 6 rather long, longer than stalk of paxilla; each spinelet has a thickened cap of skin over its tip, these caps forming conspicuous little blunt cones all over the dorsal surface. Spiracula numerous, rather large, irregularly scattered. Osculum large, about 10 mm. across; each valve with about a dozen spines,

¹ κρημνώδης = steep, in reference to the remarkable form of the jaws.

which are clothed, distally at least, with thick opaque skin; the middle spines are about twice as long as the most lateral. In each interradius is a notch about a millimeter deep, on each side of which the interbrachial membrane forms a slightly convex lobe well-supported by the actinolateral spines whose distal ends are covered with thick opaque skin. The triangular interbrachial area is about 10 mm. deep (along the interradius) and in its present contracted condition about 6–8 mm. wide along the free margin. Actinolateral spines about fifteen, of which the third or fourth seems to be the longest; the thick skin in which the spines are somewhat imbedded and the shape and condition of the specimen prevent exact determination of these points. Adambulacral armature consists of a single, acicular spine, about 3 mm. long and not at all sacculate. Aperture papillae nearly sessile, rounded triangular, not as wide as high and scarcely one third the length of the adambulacral spine. Oral plates fused to form a jaw whose length, breadth, and height (distally) are about equal; the slope from the distal end of the keel to the inner tip of the jaw is exceptionally steep; the breadth of the whole jaw, distally is probably considerably more than the height but this is hard to determine; on the outer distal corner of each oral plate are two slender oral spines 1.5–2 mm. long and just below the middle of the surface of each plate is a suboral spine about 3 mm. long and very similar to the adambulacral spines; none of these spines is at all sacculate. Color of supradorsal membrane dull bluish except where it is thickened over the tips of spinelets and spines; in such places it is yellowish white; oral surface nearly black except the interbrachial membrane between the tips of the rays which is contrastingly yellowish white.

Station 4658. Eastern Tropical Pacific, 8° 30' S., 85° 35' 36" W., 2,370 fms. Bott. temp. 35.3°. Fne. gn. m., mang. nod.

One specimen.

It is difficult to determine how much of the extraordinary bell-shape of this curious *Hymenaster* is due to contraction caused by its capture and preservation. The bell is much deeper and narrower than in Koehler's *campanulatus* and the rays do not project noticeably beyond its margin. If this were the normal form of the animal in life, the tube-feet on the proximal half of the rays would be useless; indeed progression would have to be by swimming freely in the water. It is very probable that the form of the preserved specimen is quite unnatural and is due to extreme contraction of the interbrachial areas especially along their margins. The armature of the adambulacral and oral plates is very distinctive and the coloration is also peculiar, the heavy pigmentation of the

oral surface being quite unusual. The very high and steep jaws are no less remarkable, so that entirely apart from the peculiar shape the species will be easily recognized when next it is taken.

Hymenaster trias,¹ sp. nov.

Plate 3, fig. 1, 2.

Rays 5. $R = 40$ mm.; $r = 28$ mm.; $R = 1.43$ r. Body highly arched, the vertical diameter at center being about 20 mm. but this may be due in part to marginal contraction. Form distinctly stellate, the interbrachial ares being rather deep and angular. Rays quite acuminate, the free narrow tip, about 8 mm. long, being turned up against the aboral surface of the ray. Paxillae covering the whole dorsal surface, the interbrachial areas, as seen from above, practically wanting. Paxillar spinelets five to eight usually six, longer than stalk, very slender and projecting through the thin supradorsal membrane for nearly or quite half their length. Spiracula fairly numerous, quite large, irregularly scattered. Osculum large, about 10 mm. across; each valve with twelve to fourteen spines of which the outermost are shortest but are about three fourths or at least two thirds as long as the middle ones. Actinolateral spines few and widely spaced; there are about sixteen of which the fifth is longest. The membrane in which they lie is thin and transparent. Adambulacral armature consists of two well-spaced, subequal, slender, brittle spines, 4-5 mm. long; the tip is blunt and the spines are not at all sacculate. Aperture papilla distinctly stalked, the blade about as wide as high, except that the upper margin has more or less of a membranous extension, which is, however, never very great. Oral plates united to form a very wide jaw, the width being considerably more than twice the length; the median keel is quite conspicuous but slopes gradually to the inner tip which is wide and rounded; each plate carries three oral spines, of which the innermost is as long as the jaw, or longer, and stands a trifle back from the margin and the outermost is about two thirds as long and stands on the margin near the outer proximal corner of the plate; the middle spine is intermediate in size and position. There is no suboral spine. None of the spines are sacculate. Color, both above and below, pale yellowish.

Station 4672. Peru: southwest of Palominos Light House, 88 miles, 2,845 fms. Bott. temp. 35.2°. Fne. dk. br. infus. m.

One specimen.

¹ *τρίας* = three, in reference to the armature of the oral plates.

The absence of any suboral spines distinguishes this species from any hitherto described. The three oral spines are so perfectly graduated in size and position, it would be quite unnatural to call the innermost a suboral, even though its position is not strictly marginal. Other notable features of this form are the greatly projecting paxillar spinelets, the few, slender, and widely spaced actinolateral spines, and the very long and slender adambulacral spines.

ZOROASTERIDAE.¹

The systematic position of this small but well-marked family has been the source of no little difference of opinion, but few will now question the position assigned it by Verrill and by Fisher in the Forcipulosa near the Asteroiidae. More than thirty species have been assigned to Zoroaster but the remaining genera are either monotypic or contain only two or three species. As I have had occasion to study critically the forms referred to Zoroaster, I give here a list of such species, followed by artificial keys to the genera which it seems desirable to recognize, and to the species which they contain, when not monotypic.

List of the specific names used with Zoroaster.

- fulgens* WYVILLE THOMSON, 1873. Depths of the Sea, p. 154. Northwest of the Hebrides, 767 fms.²
sigsbeeii ³ PERRIER, 1880. Comp. Rend., **91**, p. 436. Off St. Kitts, B. W. I., 120–231 fms.
aeckleyi PERRIER, 1880. *Ibid.*
diomedea VERRILL, 1884. Amer. Journ. Sci., ser. 3, **28**, p. 217. Off southern New England, 1,000–1,600 fms.
longicauda PERRIER, 1885. Ann. Sci. Nat., ser. 6, **19**, no. 8, p. 19. Eastern North Atlantic, 1,637–2,325 fms.
tenuis SLADEN, 1889. Challenger Ast., p. 421. North of New Guinea, 1,070 fms.
alfredi ALCOCK, 1893. Ann. Mag. Nat. Hist., ser. 6, **1**, p. 102. Bay of Bengal, 1,300–1,380 fms.
barathri ALCOCK, 1893. *Ibid.*, p. 103. Bay of Bengal, 1,520 fms.
planus ALCOCK, 1893. *Ibid.*, p. 104. Laccadive Sea, 1,200 fms.
angulatus ALCOCK, 1893. *Ibid.*, p. 105. Gulf of Manaar, 597 fms. Laccadive Sea, 705 fms.
carinatus ALCOCK, 1893. *Ibid.*, p. 107. Andaman Sea, 130–250 fms.
gilesii ALCOCK, 1893. *Ibid.*, p. 108. Andaman Sea, 400–500 fms.
squameus ALCOCK, 1893. *Ibid.*, p. 109. Laccadive Sea, 1,043 fms.
zea ALCOCK, 1893. *Ibid.*, p. 110. Gulf of Manaar, 597 fms. Laccadive Sea, 1,200 fms.
trispinosus KOEHLER, 1895. Rev. Biol. Nord France, **7**, no. 12, p. 6. Bay of Biscay, 360 fms.
ophiurus FISHER, 1905. Bull. U. S. Bur. Fish., **24**, p. 315. Off San Diego, Cala., 1,059 fms.

¹ Since this report was prepared, Fisher has published two important papers bearing on the morphology and taxonomy of this family: 1919, Ann. Mag. Nat. Hist., ser. 9, **3**, p. 387–393; 1919, Bull. 100 U. S. N. M., p. 470–487. As our results have been reached quite independently and are almost invariably in accord, I have let this account of the Zoroasteridae stand with very few changes.

² An unfortunate typographical error on p. 152 gives this locality as “2° 11' W. long.” On p. 144 however, it is correctly given as “9° 11' W.”

³ The name is spelled “*Sigsbeeii*” in the original publication but this is, of course, a typographical error.

- sacculatus* FISHER, 1905. *Ibid.*, p. 316. Monterey Bay, Cal., 916 fms. See *Myxoderma*.
- evermanni* FISHER, 1905. *Ibid.*, p. 317. Between San Diego and San Clemente Island, Cal., 500-507 fms.
- magnificus* LUDWIG, 1905. Mem. M. C. Z., **32**, p. 159. Gulf of Panama, 1,671 fms.
- nudus* LUDWIG, 1905. *Ibid.*, p. 161. Gulf of California, 998 fms.
- hirsutus* LUDWIG, 1905. *Ibid.*, p. 172. South of Acapulco, Mexico, 1,878 fms.
- longispinus* LUDWIG, 1905. *Ibid.*, p. 180. Eastern Tropical Pacific, 780-1,320 fms.
- spinulosus* FISHER, 1906. Bull. U. S. Fish Comm., 1903, p. 1102. Hawaiian Islands, 328-557 fms.
- bispinosus* KOEHLER, 1909. Princess-Alice Ech., p. 316. No locality given.
- adami* KOEHLER, 1909. Investigator Deep Sea Ast., p. 108. Bay of Bengal, 569 fms.
- platyocanthus* H. L. CLARK, 1913. Bull. Amer. Mus. Nat. Hist., **32**, p. 199. Off west coast of Lower California, 284 fms.
- ophiactis* FISHER, 1916. Proc. Biol. Soc. Wash., **29**, p. 29. Gulf of Tomini, Celebes, 831 fms.
- microporus* FISHER, 1916. *Ibid.*, p. 30. Southwest of Amblan Island, Moluccas, 700 fms.
- carinatus philippinensis* FISHER, 1916. *Ibid.*, p. 30. Sibuko Bay, Borneo, 415 fms.
- macracantha* H. L. CLARK, 1916. Endeavour Ech., p. 68. Great Australian Bight, 250-450 fms.
- actinocles* FISHER, 1919. Ann. Mag. Nat. Hist., ser. 9, **3**, p. 390. Aleutian Islands, 1,217 fms.
- evermanni mordax* FISHER, 1919. *Ibid.*, p. 390. Off Washington, 477 fms.

Of the above species, *tenuis* and *longispinus* are based on very young specimens, in which the real specific characters are as yet undeveloped. It is useless to attempt to compare them with the adults of other species and they are therefore omitted from the keys. Until adults are collected, accompanied by young and intermediate stages, these two names are of little service. Ludwig (1905. Mem. M. C. Z., **32**, p. 177) has described another young *Zoroaster* but he refrained from giving it a name. Koehler's record (1908. Scotia Ech., p. 566) of *tenuis* from 1,742 fms. in the extreme South Atlantic Ocean merely shows that the *genus* ranges that far south. It is highly improbable that his specimen is conspecific with Sladen's type of *tenuis*. Of course, *bispinosus* is only a slip of the pen for *trispinosus*.

The remaining twenty-nine species include several groups which seem to be worthy of rank as distinct genera. First of these is *Mammaster*, proposed by Perrier in 1894 (Travailleur and Talisman Stell., p. 125) with *Z. sigsbeeii* as the type. There is little doubt that the genus is very nearly related to *Cnemidaster* as that group now stands, thanks to Fisher's investigations (1919. Bull. 100 U. S. N. M., p. 480-484). But I do not think it will ever be necessary "to merge the two genera" as Fisher suggests. For there is a rather striking character, hitherto apparently overlooked, which distinguishes *Mammaster* at once from any of the known species of *Cnemidaster*. This is given below in the key to genera and while it may not be of great morphological importance, it affects very evidently the general appearance of the disk. The ALBATROSS collections in the Philippines have revealed so well the growth-stages of *Cnemidaster* that we can now delimit that group of East Indian and Pacific species very well.

While *Mammaster* remains monotypic, the following species are to be referred to *Cnemidaster*: — *wyvillei*, *squameus*, *zea*, *nudus*.

At the same time that he proposed *Mammaster*, Perrier also seems to propose a new genus, *Prognaster*, with *Z. longicauda* as the type. He had however, three years earlier (1891. Mem. Soc. Zool. France, 4, p. 259) given the same name and diagnosis to a genus with a new species, *grimaldii*, as the type. This earlier publication of the name is only referred to casually and ambiguously in the later paper, the user of the Travailleur and Talisman Report being thus completely and quite needlessly misled. The discovery of the many long-armed Zoroasters of the Indian Ocean has made the proposed genus as represented by *longicaudus* quite untenable and I am not able to find any satisfactory basis for separating that species from the more typical species of *Zoroaster*. But if Perrier is correct in his statement regarding *grimaldii* that the adambulaeral plates are all alike, the genus *Prognaster* may well be retained for so unique a zoroasterid.

In 1905, Fisher (Bull. U. S. Bur. Fish., 24, p. 316) proposed a subgenus *Myxoderma* for two new Zoroasters, *sacculatus* and *evermanni*, designating *sacculatus* as the type. This group, to which *platyacanthus* H. L. Clark also belongs, is well-characterized and Fisher has recently (1919. Ann. Mag. Nat. Hist., ser. 9, 3, p. 387) given it full generic rank. But *evermanni* proves to be a true Zoroaster. Another genus described by Fisher (1916. Proc. Biol. Soc. Washington, 29, p. 31) is *Bythiolophus*, based on material collected by the ALBATROSS in Buton Strait, Celebes. This seems to be quite distinct from anything hitherto known in the family. Finally mention must be made of Sladen's (1889. Challenger Ast. p. 426) genus *Pholidaster*, recently rediscovered by the ALBATROSS.

There are then seven apparently valid genera of Zoroasteridae.

Key to the genera of Zoroasteridae.

- A. Primary plates and usually additional disk-plates conspicuously large, convex (often swollen), and more or less bare.
- B. First carinal plate, just distal to primary radial, conspicuously enlarged, larger than the adjoining *second* marginals which are very much larger than the first ones; adradials wanting; three series of actinolaterals with beginnings of a fourth in large specimens. *Mammaster*.
- BB. First carinal scarcely or not at all larger than the *first* marginals which are evidently larger than the second; adradials present; four or five series of actinolateral plates. *Cnemidaster*.
- AA. Disk-plates not conspicuously convex or swollen, or if so, closely covered with spinules.
- B.¹ Adambulaeral plates all alike. *Prognaster*.
- BB.¹ Every other adambulaeral plate with a conspicuous ridge projecting into furrow and carrying long spines.

- C. Carinal plates of ray smooth and bare surrounded by series of skin-covered squamules. *Pholidaster*.
- CC. Carinal plates not surrounded by series of skin-covered squamules.
- D. A conspicuous buttress (a specialized superambulacral plate) connects first two ambulacral plates with body-wall; superambulacral plates present.
- E. Adradial plates present; superomarginals not overlapping carinals. *Myzoderma*.
- EE. Adradial plates wanting; superomarginals strongly overlapping and dominating the carinals. *Bythiolophus*.
- DD. Superambulacral plates wanting, and hence no buttresses between ambulacral plates and body-wall *Zoroaster*.

Mammaster.

PERRIER, 1894. Travailleur et Talisman Stell., p. 125.

Type-species: Zoroaster sigsbeeii PERRIER, 1880. Comp. Rend. **91**, p. 436.

This genus is still monotypic, for the allied East Indian species all differ in the character of the marginal plates at the base of the arms. Alcock (1893. Ann. Mag. Nat. Hist., ser. 6, **11**, p. 111) considers three of his eight Zoroasters congeneric with *sigsbeeii*, but he failed to note this particular feature which seems of no little importance. Fisher makes no reference to it and hence it does not seem to have attracted his attention. His work has shown that Alcock's three species are Cnemidasters but he is not sure that Mammaster can be maintained as distinct from that genus. Mammaster is evidently not common as I have found no published records of its occurrence other than those in the BLAKE Report — one station near St. Christopher in 208 fms. and one in the Gulf of Mexico is 321 fms.; seven specimens altogether. The largest of the BLAKE specimens had R about 75 mm. Perrier selected a much smaller specimen (R = 49 mm.) for his description and does not refer to the large one.

CNEMIDASTER.

SLADEN, 1889. Challenger Ast., p. 423.

Type-species: C. wyvillii SLADEN, 1889. *Loc cit.* Monotypic when established.

The collections made by the ALBATROSS in the Far East have enabled Fisher to revolutionize our knowledge of this genus, which was based on a single very immature specimen. Fisher had seven specimens at his disposal and has been able to make clear some of the growth-changes. These bring out the important fact that the Zoroasters described under the names *nudus*, *squameus*, and *zea* are all congeneric with *wyvillii*. Indeed the four species are so closely related, it is exceedingly difficult to separate them properly. The following key is the result of studying cotypes of *nudus* and *squameus*, and the descriptions and

figures of *zea* and *wywillii* published by Alcock, Sladen, and Fisher. But as I have not seen a specimen of either of these last two forms, which Fisher intimates may be identical, I consider the number of valid species in *Cnemidaster* still uncertain. I think *nudus* is undoubtedly distinct from the East Indian forms but the three latter are certainly very closely allied.

Key to the species of Cnemidaster.

- Spinelets of actinal surface with thin sacculation scarcely noticeable when dry, not covering the plates very closely.
 - Distal carinals, and often marginals, with a central spine about as long as plate. *wywillii*.
 - Distal carinals and marginals unarmed, but often with one or more minute spinelets or elongated granules. *nudus*.
- Spinelets of actinal surface flat, more or less squamiform, with heavy sacculation, closely covering the plates.
 - Intermarginal papulae present; adambulacral ridge (on each alternate plate) with three stout spinelets. *squamatus*.
 - Intermarginal papulae wanting; adambulacral ridge "bearing a row of three sabre-shaped spines and deep within the furrow a slender spinelet". *zea*.

Prognaster.

PERRIER, 1891. Mem. Soc. Zool. France, 4, p. 259.
Type-species: P. grimaldii PERRIER, 1891. *Loc. cit.*

Perrier, in his later, fuller account (1896. *Hirondelle Stell.*, p. 22), says very emphatically that so far as he could see the adambulacral plates all extend equally into the furrow. This is so unusual a character for an adult zoroasterid that one can but suspect that Perrier has failed to examine the adambulacral margin with sufficient care. If he is correct, the genus is easily recognizable. The only known species was taken by the Prince of Monaco, near the Azores, in 1,568 fms.

Pholidaster.

SLADEN, 1889. *Challenger Ast.*, p. 426.
Type-species: P. squamatus SLADEN, 1889. *Loc. cit.*

Although Sladen published a short notice of this genus in 1885, he mentioned no species and hence the name must date from 1889. He never designated a type but Fisher (1919. *Bull.* 100 U. S. N. M., p. 484) has done so. The two known species were taken in the East Indian region: — *squamatus* in the Philippines in 100 fms. and *distinctus* in the Banda Sea in 140 fms. The ALBATROSS took *squamatus* at five stations in the Philippines in 108–218 fms. These are all remarkably slight depths for a member of this family.

Key to the species of Pholidaster.

Superomarginals and most of the disk-plates concealed by flat, skin-covered scales. *squamatus*.
 Superomarginals and primary disk-scales largely bare. *distinctus*.

Myxoderma.

FISHER, 1905. Bull. U. S. Bur. Fish., **24**, p. 316, as a subgenus of *Zoroaster*.

Type-species: M. sacculatus FISHER, 1905. *Loc. cit.*

This small group of sea-stars occurring off the coast of the western United States and Lower California in 284–916 fms. is well-circumscribed and Fisher has wisely (1919. Ann. Mag. Nat. Hist., ser. 9, **3**, p. 392) raised it to full generic rank. In the same paper he has described a subspecies of each of the two component species but I doubt whether sufficient material has yet been secured to warrant recognition of subspecies. In any case, however, he has set forth so well the characters of these supposed subspecies in his key, that we need not discuss them here. There are certainly two valid species.

Key to the species of Myxoderma.

Spines and spinelets more or less conspicuously sacculate; big pedicellariae in ambulacral furrow or on adambulacral spines; papulae in adults 3–5 in an area on base of rays abactinally. . . . *sacculatum*.
 Spines and spinelets little or not at all sacculate; no big pedicellariae in furrow or on adambulacral spines; papulae 1 or 2 in an area on base of rays abactinally. *platyacanthum*.

Bythiolophus.

FISHER, 1916. Proc. Biol. Soc. Wash., **29**, p. 31, 1919. Bull. 100 U. S. N. M., p. 484, pl. 135, fig. 1–1c, 139, fig. 1, 2.

Type-species: B. acanthinus FISHER, 1916. *Loc. cit.*

This monotypic genus is based on a single sea-star taken by the ALBATROSS in Buton Strait, Celebes, in 559 fms. It is unquestionably a well-marked and noteworthy type. In the diagnosis as published in 1919, the presence of *sub-ambulacral* plates is mentioned; Dr. Fisher assures me this is a slip for *super-ambulacral*. In the key to genera of Zoroasteridae (1919, p. 471) *Bythiolophus* is said to have no adradial plates and in the figures 1 and 1c, pl. 135, as well as in the explanation of the plate, the series of plates adjoining the carinals on each side is called the superomarginal. But in the diagnosis of the genus (p. 484) and in the diagnosis and description of the species (p. 485) this series is considered as adradial and the prominence of the adradial plates is emphasized. Dr. Fisher writes me that the key was prepared much later than the text and is

correct. There are no adradials. "The prominent plates immediately adjacent to the carinals and overlapping them are almost certainly the superomarginals. . . . There are therefore on each side of the carinals 2 series of marginals and 5 actinolateral series. The superomarginals are alternately larger and smaller."

Zoroaster.

WYVILLE THOMSON, 1873. Depths of the Sea, p. 154.

Type-species: *Z. fulgens* WYVILLE THOMSON, 1873. Loc. cit.

Even as here restricted, this genus contains twenty-two species, and two subspecies. It is no easy matter to separate them from each other, for the specific characters are not numerous and several are very ill-defined, so that even when species look as unlike as *fulgens* and *longicaudus* it is not easy to express their differences briefly with reliable accuracy. So little is known of growth-changes in the genus, it is quite likely the key given below will prove of little use with young specimens. The condition of the adradial series of plates furnishes the most important divisional character as it usually shows relatively little growth-change, and yet in *ackleyi* at least, it is well-marked in specimens with $R = 50$ mm. and quite concealed when $R = 100$ mm. The character and degree of armature of the carinal and superomarginal plates furnish good but less reliable features, and the tuberculation and spinulation of the actinolateral plates are of some service. But the relative length of arm increases more or less considerably with age and consequently body-form and proportions are not reliable, while the armature of the adambulacral and oral plates shows relatively little diversity in the genus. Nevertheless specific lines can be drawn with more or less accuracy and the following key will help to differentiate the species. It includes the new species described below, as well as the subspecies named by Fisher.

Key to the species of *Zoroaster*.

- A. Adradial series of plates well-developed at least on basal half of ray.
- B. Superomarginals, some or all, armed with a central spine.
- C. Most skeletal plates, except some or all adradials, with a stout central spine.
 - D. Abactinal plates nearly or quite without spinelets. *perarmatus*.
 - DD. Abactinal plates well-covered with spinelets.
 - E. No large pedicellaria regularly on second spine of projecting adambulacral plates.
 - evermanni*.
 - EE. A huge pedicellaria on second spine of each projecting adambulacral plate.
 - evermanni mordax*.
- CC. Most skeletal plates without a central spine.
 - D.¹ Carinal plates wider than long; superomarginal spines irregularly developed, often wanting on most of the plates.

- E.¹ Armature of actinolateral plates with a central, slender spine longer than its fellows.
- F. Fourth actinolateral series of plates present; superomarginal spines not much more slender than carinal spines; spinelets scarcely fleshy.....*fulgens*.¹
- FF. Fourth actinolateral series rudimentary; superomarginal spines decidedly more slender than those on carinals; spinelets fleshier.....*actinodes*.²
- EE.¹ Armature of actinolateral plates with a trio of subequal spines longer than the others.
trispinosus.
- DD.¹ Carinal plates as long as wide or longer; superomarginal spines usually well-developed and often forming conspicuous series.....*diomedae*.
- BB. Superomarginal plates unarmed.
- C.¹ Carinal plates unarmed.
- D.² Covering of skeletal plates a close capillary spinulation.
- E.² Intraambulacral ridge (of alternate adambulacra) with two spines, the outer with a huge pedicellaria at tip.....*barothri*.
- EE.² Intraambulacral ridge with three or four spines and no huge pedicellaria.....*ackleyi* juv.
- DD.² Covering of skeletal plates made up of fine granules, little elongated; intraambulacral ridge with one spine and no huge pedicellaria.....*adami*.
- CC.¹ Carinal plates armed with a more or less conspicuous central spine.
- D.³ Actinolateral plates with a conspicuous central spine-bearing tubercle.
- E.³ Each adambulacral plate with two bunches of pedicellariae high up in furrow....*alfredi*.
- EE.³ No such bunches of pedicellariae.
- F.¹ Rays strongly carinate; innermost adambulacral spine with a terminal tuft of about ten pedicellariae.....*ophiactis*.
- FF.¹ Rays not strongly carinate; innermost adambulacral spine with four to eight pedicellariae near tip.
- G. Disk-plates unarmed; rays very long, slightly swollen at base and then tapering steadily to a slender tip; R = 18-20 r.....*magnificus*.
- GG. Primary plates of disk armed with a central spine.
- H. Disk and arm-bases more or less depressed; non-projecting adambulacral plates with only two spines.....*planus*.
- HH. Disk and arm-bases not depressed; non-projecting adambulacral plates with about four spines.....*hirsutus*.
- DD.³ No conspicuous tubercle near center of actinolateral plates though one tubercle may be somewhat larger than others.
- E.⁴ R = 16-18r; arms slender and tapering; no huge pedicellariae on adambulacral plates.
longicaudus.
- EE.⁴ R = 10-15r; arms stouter and less tapering; huge pedicellariae present on adambulacral plates.....*spinulosus*.
- AA. Adradial series of plates more or less reduced or wanting, their place often occupied by a conspicuous groove (*sulcus*) on each side of carinal series of plates.
- B.¹ Disk large, low, very distinctly delimited from rays by a ring of massive, semiglobular plates; primary plates all massive and semiglobular; all plates covered with capillary spinelets with a few coarser spinelets interspersed.....*gilesii*.
- BB.¹ Disk not as above.
- C.² Superomarginal plates conspicuously armed with a central spine.....*macracanthus*.
- CC.² Superomarginal plates practically unarmed.
- D.⁴ Adambulacral plates with two transverse series of actinal spinelets.
- E.⁵ Carinal plates armed, deeply notched on both sides.....*angulatus*.
- EE.⁵ Carinal plates unarmed, squarish.....*microporus*.

¹ The figures given by Sladen (Challenger Ast., pl. 66) purporting to be *fulgens* are almost certainly *diomedae*, for Sladen called all the western Atlantic specimens *fulgens*; his description too seems to have been made from the American form. This unfortunate state of affairs is misleading and may be why Koehler considered his Bay of Biscay specimen a new species (*trispinosus*) instead of referring them to *fulgens*. The differences between *trispinosus* and Sladen's *fulgens* are evident, but comparison of Koehler's descriptions and figures with a true *fulgens* leads one to suspect they are identical.

² As Fisher's description is brief and comparative, I am not sure that my summary of the distinguishing features will prove reliable.

- DD.⁴ Adambulacral plates with only one transverse series of actinal spines.
 E.⁶ Abactinal surface with coarse spinulation and numerous big pedicellariae . . . *ophiurus*.
 EE.⁶ Abactinal surface with fine spinulation and few inconspicuous pedicellariae.
 F.² Carinal plates at base of arm quadrilateral much wider than long; superomarginals similar but smaller *ackleyi* adult.
 FF.² Carinal plates about as long as wide with lateral margins more or less deeply notched; superomarginals irregularly diamond-shaped with rounded angles, not much wider than long.
 G.¹ Adambulacral furrows with few pedicellariae *carinatus*.
 GG.¹ Adambulacral furrows with many pedicellariae *carinatus philippinensis*.

Zoroaster perarmatus,¹ sp. nov.

Plate 4, fig. 2.

R = 98 or 125 mm.; r = 13 or 18 mm.; R = 7-7.5 r. Disk moderately large, not elevated above nor distinctly set off from rays. Primary plates distinguishable but not conspicuous and not at all swollen. Rays rather stout, the height at base equalling or exceeding the width, which is about .15-.17 of the length; rays tapering to a blunt tip, more slender in the larger specimen than in the smaller. Carinals moderate, wider than long, lateral margins narrowed by large papular areas. Adradial plates moderately well-developed, at least on basal part of arm, much longer than wide and nearly quadrilateral. Superomarginals similar to carinals but only about half as large. Inferomarginals similar but somewhat smaller and relatively longer. Actinolaterals in four series (on basal part of arm), nearly square and closely joined, the papular pores being very small. There is no indication of imbrication among either the marginal or actinolateral plates. Madreporite 2-3 mm. across, rather prominent, close to disk-margin, surrounded by five or six spinelets.

The great majority of the skeletal plates are more or less elevated at or near the middle into a conspicuous spine-bearing tubercle; the spine on the disk-plates, carinals, marginals, and adradials being stout and erect, .75-2 mm. high and .30-.90 mm. thick at base; on the actinolaterals the spine is often wanting but when present reaches a length of 5 mm. and a thickness of 1 mm. at base; in the smaller specimen, the spines are all erect, standing out at right angles to the plate-surface, but in the larger specimen, the actinolateral spines are all more or less appressed to the sides of the ray. On the disk-plates, carinals, adradials, and marginals, there are *no secondary or miliary spines whatever*, but there are numerous big pedicellariae, 1-2 mm. long. Actinolateral plates well-covered with rather stout spinelets, about ten to a plate; in alcohol, these spinelets are conspicuously sacculate but when dry the saccule disappears and

¹ *perarmatus* = thoroughly armed; in reference to the extreme development of primary spines.

they appear slender and pointed. Pedicellariae also occur on the actinolateral plates but they are not so large as abactinally. In alcoholic material, the rather thick abactinal skin is everywhere elevated into little soft knobs as many as ten or twelve occurring on a single disk-plate; these completely disappear when the material is dried. Papulae abundant all over dorsal surface, clear to arm-tips; usually there is only one to an area but on disk and arm-bases three or four may be found in one area; below the inferomarginals, papulae are very few and small and none occur below the second series of actinolateral plates.

Adambulacral plates rather longer than usual in *Zoroaster*; in the alternate small plates, length nearly equals breadth. Each small plate has on its actinal surface in two series, three to five spinelets, the largest being on the furrow-margin; are all more or less sacculate in alcoholic material; the largest spinelet is frequently replaced by a large pedicellaria and this is particularly so in the larger specimen. Each projecting adambulacral plate has on its actinal surface in two transverse series, four or five spinelets similar to those on the smaller plates, and in addition, there are three much stouter spines on the intraambulacral ridge; of these the innermost is smallest and carries at its tip a huge pedicellaria and two or three small ones; the second spine is thick and blunt, about 2–2.5 mm. long by .50–.60 mm. thick at base; the outermost spine is similar but larger, 3–3.5 mm. long, .60–.80 mm. thick. Of other pedicellariae on the adambulacral plates or spines, there are very few or none. Oral plates short and small; each carries three or four spines, of which the innermost is shortest, stands on the outer proximal corner of plate and carries at its tip a huge pedicellaria and one or two smaller ones; the second spine is more slender and stands nearer the radial line; back of it stands the third and stoutest spine; back of the latter is the fourth spine when it is present, but it may be wanting or it may be replaced by a huge pedicellaria. Pedicellariae of varied size may occur on the sides and at the inner end of the oral plates and in the larger specimen they are quite abundant.

Color in alcohol yellow-brown, but this fades out on drying into a dirty whitish, with papular areas darker and papulae almost black.

Station 4653. West of Peru about 17 miles, 5° 37' S., 81° 24' W., 536 fms. Bott. temp. 41.3°. Dk. br. gy. shore m.

Two specimens.

The general appearance of these two specimens is at first glance quite unlike but when they are carefully compared they are found to be remarkably

similar. The difference in appearance is due to the more erect position of the spines in the smaller specimen and to the greater abundance of pedicellariae in the larger. The latter also has much more tapering arms.

The species is one of the best characterized in the genus for the development of primary spines on so many abactinal plates, accompanied as it is by the total absence of small spines, gives a very easily recognized facies. There is little doubt that *perarmatus* is more closely allied to *fulgens* and *diomedae* than is any other one of the eastern Pacific Zoroasters.

Zoroaster magnificus.

LUDWIG, 1905. Mem. M. C. Z., 32, p. 159.

There is a fine large Zoroaster in the present collection, R = 270 mm., r = 15 mm., which has been labeled by Ludwig as *Z. magnificus*. It answers well to the description except in one particular; the spinelets covering the body are thick and blunt and even when dry are not in the least "sabelförmig" as they are described in *magnificus*. If this difference is anything more than of degree, it might be of considerable importance but as I have no available specimen of *magnificus* for comparison, I attribute it to individual diversity merely.

Station 4647. Eastern Tropical Pacific, 4° 33' S., 87° 42' 30'' W., 2,005 fms. Bott. temp. 35.5°. Lt. gy. and br. glob. oz.

ASTERIIDAE.

Heliaster cumingii.

Asterias (Heliaster) cumingii GRAY, 1840. Ann. Mag. Nat. Hist., 6, p. 180.

Heliaster cumingii DUJARDIN AND HUPÉ, 1862. Hist. Nat. Zoöph. Ech., p. 343.

These two specimens, measuring about 200 mm. across, were taken in January, 1905, at Chatham Island, Galapagos, a locality from which the species has long been known. One has thirty-six and the other thirty-eight rays.

Heliaster multiradiatus.

Asterias (Heliaster) multiradiata GRAY, 1840. Ann. Mag. Nat. Hist., 6, p. 180.

Heliaster multiradiatus DUJARDIN AND HUPÉ, 1862. Hist. Nat. Zoöph. Ech., p. 343.

There are two specimens of this species, taken with the preceding. One has R = 65-70 mm. and the other has R = 75-80 mm. Each has twenty-six rays, nearly the maximum number for the species.

Stylasterias paschae,¹ sp. nov.

Plate 4, fig. 3.

Rays *nine*. R = 100 mm.; r = 10 mm.; R = 10 r. Br. = about 10 mm. Disk small, flat, covered with a rather heavy skeleton, the plates of which are much more closely united around the margin than near the center. Rays tapering but little, quite flat, with wide ambulaeral grooves. Abaetinal skeleton of ray made up of a carinal series of plates, a dorsolateral series on each side and the superomarginal series. Actinal skeleton composed only of large, inferomarginals and adambulaerals; there are no actinolateral plates present. Carinal plates longer than wide, abruptly wider distally than proximally; the narrow proximal end overlaps the wide distal end of the next proximal plate; every other plate is swollen near center or towards proximal end to support a large spine-bearing tubercle. Dorsolateral plates somewhat smaller than carinals, but like them in that every other one bears a spine-carrying tubercle; these plates seem to be placed obliquely, the outer end, which overlaps the upper side of a superomarginal, being more distal than the inner end. Superomarginal plates roughly cruceiform with rounded ends, much wider than long; the lowest end overlaps the upper side of an inferomarginal; every other plate has a large spine-bearing tubercle while each of the alternate plates carries a single large pedicellaria. It seems probable that in life the spine-bearing carinals and superomarginals are about opposite each other, while the spine-bearing dorsolateral plates alternate with them. This arrangement is not evident however, in the present, dry specimen. Each of the dorsal spine-bearing plates, both on disk and on arms, carries a stout bluntly pointed spine, 2-3 mm. long and .50-.70 mm. thick at base. Each spine is surrounded at or near its base by a wreath of minute pedicellariae. Besides these forcipulate pedicellariae and the large forficulate ones on alternate superomarginals, forficulate pedicellariae of diverse sizes, but none either very large or very small, are scattered irregularly about all over the dorsal surface. Papular areas rather large, those near the base of each arm with six or even more papulae. Madreporite small, surrounded by six large spines, placed near disk-margin.

Inferomarginal plates smaller than superomarginals; each plate bears an oblique ridge the lower end of which is more distal than the upper; on this ridge is a series of three spines (sometimes only two) of which the uppermost is a trifle the longest and least chisel-shaped at tip, while the lowest is a trifle the shortest

¹ *Pascha* = Easter; obviously in reference to the type-locality.

and most chisel-shaped; the middle spine is a trifle the widest and heaviest; besides the spines, many inferomarginal plates carry a huge forciform pedicellaria, 1.5 mm. long and 1 mm. wide at base; the uppermost inferomarginal spine often carries a cluster of forciform pedicellariae on its upper side near the middle or more distally.

Adambulacral plates short and crowded; each carries a pair of subequal, flattened, narrow, chisel-shaped spines about 2.5 mm. long; many plates carry also a huge forciform pedicellaria, 1.5 mm. long by 1 mm. wide, placed on the inner distal angle of the plate and hence more or less within the ambulacral furrow; there are also a few very small forciform pedicellariae scattered along the sides of the furrow. Oral plates small, each with two large spines; one at inner end of plate is about 3 mm. long and over a millimeter wide at its flattened base; the other is on the surface of the plate near its outer end and is distinctly longer and narrower. Tube-feet distinctly quadriserial, rather slender, not very crowded.

Color, light brownish yellow (dried) with the spines and pedicellariae nearly white.

Easter Island; shore. December 21, 1904.

One specimen.

This is one of the most interesting starfishes brought home by the ALBATROSS, not only because of the distinctive combination of characters which it shows, but because of its locality. It is noteworthy indeed to find on the shores of so isolated an island a well-marked member of a genus whose nearest species is thousands of miles away. Yet there is no doubt that this Easter Island starfish is a typical *Stylasterias*, save for the large number of rays; the other members of the genus all belong to the northern hemisphere, only one occurring as far south as the equator. The number of rays, the presence of three inferomarginal spines and the character and distribution of the pedicellariae serve to distinguish *paschae* from any other *Stylasterias*. Verrill suggested the group only as a subgenus of *Orthasterias* but it seems to be well-circumscribed and is a convenient group to use, once the disintegration of *Asterias* is permitted to set in.

BRISINGIDAE.

Fisher's (1917. Ann. Mag. Nat. Hist., ser. 8, 20, p. 418-431) recent thoroughgoing revision of this family, in which he recognizes fifteen genera, makes it possible as never before to appreciate the diversity it shows. It also reveals

how many notable forms are recent discoveries, and emphasizes the fact that we are as yet far from realizing the entire content of the family. This idea is still further emphasized by the present collection, for while there are only eight disks and some scattered arms from but five stations, no fewer than five species are represented and four of these are new to science.¹ The one previously described species moreover has hitherto been known only from the eastern tropical Atlantic, where it was taken by the CHALLENGER! Three of the five species were taken at a single station. These facts all go to show how very incomplete our knowledge of this remarkable deep-sea family still is. Of very few species has sufficient material been secured to permit real knowledge of the specific characters, and there is not a single form of which the growth-changes and the limits of individual diversity are known. Under such circumstances the addition of new species based on single and more or less fragmentary specimens is not very desirable, but on the other hand material so rare and so difficult to secure must not be ignored. The following notes may be of service in elucidating generic and specific limits within the family.

***Brisingella monacantha*,**² sp. nov.

Plate 5, fig. 3, 4.

Disk and number of rays unknown. Rays about 200 mm. long, 4 mm. wide at base, 5.5 mm. wide at middle of genital area and 2.75 mm. wide one hundred millimeters from base. Genital area begins 10 mm. from proximal end of ray and extends about 25 mm.; it is covered by delicate naked gray skin and is crossed by eleven or twelve calcareous ridges ("primary costae" of Fisher); there are three or four additional costae distal to the swollen area and indications of four or five more proximal to it; there are two incomplete or secondary costae on each ray; otherwise there is no calcareous material on dorsal side of rays. Adambulaeal plates about 2 mm. long on proximal half of ray, somewhat shorter distally; width at proximal end about half length, distinctly less at middle and slightly more at distal end where there is a marked projection or peak on the inner corner; at the base of this peak on the actinal surface of plate but close to the adambulaeal margin is a distinct spine-bearing tubercle; on proximal part of arm, there is a fairly close approximation between costae and

¹ It is interesting to note that all of the specimens were taken in water more than 2,200 fms. deep and at a temperature lower than 36° F.

² *monacanthus* = having a single thorn or spine, in reference to the armature of the adambulaeal plates.

adambulaeral plates. Inferomarginal plates very small and difficult to detect; apparently only every alternate plate carries a spine but proximally this alternation is not perfect as there two successive plates may be spine-bearing. Adambulaeral armature consisting of a single spine; on no plate is there any indication of a furrow-spine or of a point to which it might have been attached. Both inferomarginal and adambulaeral spines are for the most part missing or when present are broken, but to judge from the fragments distally the inferomarginals were the larger and both series were encased in thick skin. Inferomarginal tubercles are placed directly above adambulaeral tubercles but only adjoining every other adambulaeral plate. Tube-feet of moderate size arranged in pairs opposite the distal half of the adambulaeral plates; pores about one millimeter in diameter. Genital glands moderately developed, one on each side of swollen area.

Station 4651. Peru: west of Aguja Point, 111 miles, 2,222 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Two rays.

Comparison of these rays with Fisher's figures and description of *Brisinga fragilis* (1906. Bull. U. S. Fish Comm., p. 1115, plate 46, fig. 1, plate 48, fig. 3, 3a-e), the genotype of *Brisingella*, has left no doubt in my mind that they too represent a species of this genus, and one which is apparently unique in its adambulaeral armature. As the uniform absence of a furrow-spine at either end of the adambulaeral plate and the equally uniform occurrence of only a single actinal spine on the same plates and that aboral, make the recognition of the species easy, it seems proper to give it a name.

***Freyellidea brevispina*,¹ sp. nov.**

Plate 5, fig. 1, 2.

Rays 11. Disk 12 mm. across. R = 165 mm. or more. R = about 14d. Disk circular with nearly vertical sides between the rays, densely beset with spinelets, .50-.75 mm. long; these spinelets are slender, slightly thickened at tip where they terminate in two, three, or four short points; occasionally the tip is blunt; the plates bearing these spinelets are difficult to make out but apparently there is only one spinelet to a plate; pedicellariae of diverse but small size occur not rarely among the spinelets. Madreporite small but elevated and prominent on the margin of disk. Rays slender, only a little over 2 mm. wide

¹ *brevispinus* = having short spines, in reference to the unusual oral spines.

at base and with a maximum width, about 12 mm. from base, of only 4 mm.; genital area very short only about one tenth of ray-length, covered closely by plates, spinelets, and pedicellariae like those of disk but notably smaller; beyond genital area, minute pedicellariae continue for a few joints only on the dorsal surface; along sides of ray however, they continue more or less abundantly, and distally they again invade the dorsal surface, so that the tips of the rays are apparently enclosed in skin densely covered with these very minute pedicellariae.

Adambulacral plates long and narrow, about 2 mm. by .75, so little concave on the furrow-side that they are almost cylindrical; there is a moderately developed peak at the inner, distal corner; their armature consists of two spinelets, one of these is placed on the inner peak of the plate and extends diagonally across the furrow, while the other is near the center of the plate, or a little distal to it, on the actinal surface; the furrow-spine is short and thick, not much longer than width of furrow, and bears a number (5-8) of small pedicellariae; the actinal spine is very slender, only about 3 mm. long at base of arm but becoming 5 mm. long on distal part of ray; it is very acicular but is clothed in loose skin, densely covered with very minute pedicellariae and unless this skin is damaged, the slenderness of the spine is not apparent. Above every other actinal spine is an inferomarginal spine which at base of arm is only 4 mm. long but reaches a maximum length of at least 7 mm. distally; the actinal spines overlaid by the inferomarginals are always noticeably smaller than those which are unaccompanied, but the latter are not so large as the inferomarginals; like the actinal spines, the inferomarginals are clothed in thick, pedicellaria-covered skin. Tube-feet moderate, in pairs opposite distal part of adambulacrals; pores about 1 mm. across. Oral plates short, moderately high at distal end with a keel along midradial line; each plate carries near distal end a long, slender skin covered spine, about 5 mm. long, distinctly thickened at tip; at distal outer corner a small, pedicellariae-bearing spinelet like that of the adambulacral plates; and at inner end, two, or rarely three, short, more or less curved, flattened, wide spinelets, much wider at tip than at base; some are so wide at tip as to be almost fan-shaped; inner is much smaller than outer; the latter may be over a millimeter long and nearly a millimeter wide at tip; these inner oral spines are not skin-covered and carry no pedicellariae. Color, in alcohol, nearly white.

Station 4740. Eastern Tropical Pacific, 9° 2' S., 123° 20' W., 2,422 fms. Bott. temp. 34.2°. Dk. gy. glob. and rad. oz.

One specimen.

Examination of the rays shows that there is no evidence of a syzygy at the base; all of them are still attached to the disk, though broken at a greater or less distance from it. The arrangement of marginal, adambulacral, and oral plates about the mouth seems to be like that of *Freyellidea microplax*, the genotype. There is a single genital gland on each side of the swollen area at base of ray. The combination of characters which serves to separate this species from all those previously known lies in the very long, slender arms, the unusually short inferomarginal and adambulacral spines, and the extraordinary oral spinelets.

Freyellidea octoradiata,¹ sp. nov.

Plate 6, fig. 1, 2.

Rays 8. Disk 16 mm. across. Rays about 185 mm. long or perhaps more (the tips are missing). R = about 12d. Disk high and slightly tumid, closely covered with thick overlapping plates, a millimeter across, more or less; in each interradius, the large interradiial plate is conspicuous, occupying the whole side of the disk in those areas; interradiial plates smooth and bare, but all other disk-plates with several (usually three or four) small, slender spines and rarely one or two pedicellariae; the latter are nearly always on plates near arm-bases; spinelets about .50 mm. long, with blunt and often slightly swollen tips. Rays rather stout, about 5.5 mm. wide at base and 3 mm. wide near middle; genital area about 35 mm. long and 8 mm. wide, where widest. Basal fourth of ray more or less covered with spiniferous plates, similar to those of the disk but larger and carrying more spinelets and pedicellariae; as far out as the genital area extends, these plates are close together and cover the region completely but beyond that point they become more and more separated, fewer in number and smaller in size, until they finally disappear as very minute fragments carrying a single pedicellaria; on the genital area the plates are, as a rule, much wider than long, and the largest exceed 2 mm. in breadth; near tip, pedicellariae-covered skin clothes dorsal and lateral parts of ray.

Adambulacral plates rather short and stout, nearly cylindrical; thickness more than half length; inner, aboral peak present but slender; armature as usual in the genus; a short spinelet on the peak, extending across furrow and carrying small pedicellariae; and a large actinal spinelet, the tubercle of which occupies a large part of distal half of plate; near base of arm, these actinal spinelets are very stout with enormously widened flat, dentate tips, as in *F. insignis*

¹ *octoradiatus* = having eight rays, in reference to the unusually small number of arms.

but heavier than in that species; beyond genital area, they rapidly assume an ordinary blunt tip; where longest they are about 5 mm. long and decrease in length and stoutness distally. Inferomarginal spines at first rather small, not equalling the actinal adambulacral spines, but distally they gradually come to exceed them; as usual there are two actinal spines to one inferomarginal, the latter overlying one of the former. Both actinal and inferomarginal spines are more or less completely encased in pedicellariae-covered skin. Tube-feet very large, the pore occupying nearly the whole area bordered by the adambulacral plate. Oral plates small, with no midradial keel; at distal outer corner is a small spinelet similar in position and appearance to the adambulacral furrow-spine, while on the adoral margin are two similar but longer spines which widely diverge from each other; at the center of the actinal surface of the plate is a long spine, like the adambulacral actinal spines, with a conspicuously flat dentate tip; all the oral spines carry numerous pedicellariae. Color, in alcohol, light buff.

Station 4649. Eastern Tropical Pacific, 5° 17' S., 85° 19' 30'' W., 2,235 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Station 4740. Eastern Tropical Pacific, 9° 2' S., 123° 20' W., 2,422 fms. Bott. temp. 34.2°. Dk. gy. glob. and rad. oz.

Station 4742. Eastern Tropical Pacific, 0° 3' 29'' N., 117° 15' 48'' W., 2,320 fms. Bott. temp. 34.3°. Fne. lt. gy. glob. oz.

Three specimens.

Two of these specimens are of nearly equal size but the one from St. 4740 is very much younger. The disk is only 7 mm. across; two of the arms are broken near the disk, the others near their tips or beyond the genital area, which is little enlarged. None of the adambulacral actinal spines show very much expanded tips but they are relatively short and in view of the number of rays, I consider this specimen *octoradiata*.

The small number of rays, apparently quite constant, the large feet, the short, thick adambulacral plates, and the relatively short actinal and inferomarginal spines combine to give this species a very characteristic facies. The disk too is relatively small and the rather stout arms are longer than usual. The generic characters are well shown, as there is no syzygy at the base of the arm, the genital tufts are single on each side of the arm and the interradian angle is as in *microplax* except for the very much larger interradian plate.

***Freyellidea oligobrachia*,¹ sp. nov.**

Plate 6, fig. 3, 4.

Rays 6. Disk 10 mm. across. Rays all broken but certainly more than 90 mm. long and probably in excess of 100. Disk moderately high but flat, covered with relatively large, thick, irregular plates which more or less overlap; the largest are about .75 mm. in diameter and carry as many as fifteen spinelets; spinelets very small with one, two, or three glassy terminal points; around anus the spinelets are noticeably coarser; there are a few small pedicellariae scattered among the spinelets. Rays rather stout, about 4 mm. wide at base, and 3 mm. near middle; genital area not sharply defined, about 20 mm. long and only 4.5 mm. wide, where widest; its covering is very similar to that of the disk, except that spinelets are fewer and pedicellariae much more numerous; beyond genital area, the plates disappear quite rapidly.

Adambulacral plates long and slender, the distal end curved inward slightly, its inner corner prolonged into a long slender peak; armature, of a single spine about 3 mm. long, which is located on aboral end of plate on actinal surface, and is normally covered with thick skin, densely clothed with pedicellariae; at base of ray these spines have flat, expanded, dentate tips but these rapidly give way to simple points and distally the spines are very acicular; there is no furrow-spine and no pedicellariae in the furrow. Inferomarginal spines small, acicular, completely skin covered like the actinal spines, which they seldom equal in length and never exceed; basally they occur at irregular intervals of 2-4 adambulacral plates but distally they are more regular and seem to accompany every other actinal spine. Tube-feet rather small, lying against the distal curved end of adambulacrals. Oral plates small, squarish, little swollen; on actinal surface at distal end is a long, clavate spine covered with skin and numerous pedicellariae; at adoral outer corner of plate are two or three slender spinelets lying horizontally and each carrying a few pedicellariae. There is no spinelet at distal outer corner of plate but there are a few pedicellariae in the furrow at that point. Color, in alcohol, nearly white.

Station 4656. Eastern Tropical Pacific, 6° 54' 36" S., 83° 34' 18" W., 2,222 fms. Bott. temp. 35.2°. Fne. gn. m., mang. nod.

Station 4742. Eastern Tropical Pacific, 0° 3' 24" N., 117° 15' 48" W., 2,320 fms. Bott. temp. 34.3°. Fne. lt. gy. glob. oz.

Three specimens.

¹ $\delta\lambda\iota\gamma\omicron\varsigma$ = few + $\beta\rho\alpha\chi\iota\omega\nu$ = arm, in reference to the number of rays, the minimum for the genus.

The specimen described is the largest and is from St. 4742. The one from St. 4656 is smaller, with disk only 6 mm. across; in all particulars however, it agrees with the holotype. The third specimen is from St. 4742 and measures only 4 mm. across the disk; it is surprisingly like the holotype and offers no features worthy of special comment. The generic characters are well shown by the holotype, in which the base of each ray contains a well-developed genital tuft on each side. The junction of the oral plates with the interradyal is very clear in the specimen from St. 4656. The rays of all the specimens are still attached to the disk, though several are broken off near the base. The presence of six rays and the absence of a furrow-spine ally this species with the following, but the general facies is quite different. They evidently form a very distinct section of the genus.

***Freyellidea tuberculata*.**

Freyella tuberculata SLADEN, 1889. Challenger Ast., p. 638.

Freyellidea tuberculata FISHER, 1917. Ann. Mag. Nat. Hist., ser. 8, 20, p. 429.

The specimen at hand is of just the same size as the one described by Sladen, having the disk 12 mm. across and the rays 240 mm. long. It answers to the description in practically every particular and I have sought in vain for some character by which the Pacific form might be separated from the Atlantic. There is then in the discovery of this species in the Pacific by the ALBATROSS further evidence in support of the view that the true deep-sea fauna is essentially cosmopolitan.

Station 4742. Eastern Tropical Pacific, 0° 3' 24" N., 117° 15' 48" W., 2,320 fms. Bott. temp. 34.3°. Fne. lt. gy. glob. oz.

One specimen and three additional arms.

EXPLANATION OF THE PLATES.

PLATE 1.

PLATE 1.

Thoracaster magnus Ludwig. Cotype from Station 4717. Nat. size.

1. Upper surface.
2. Lower surface.

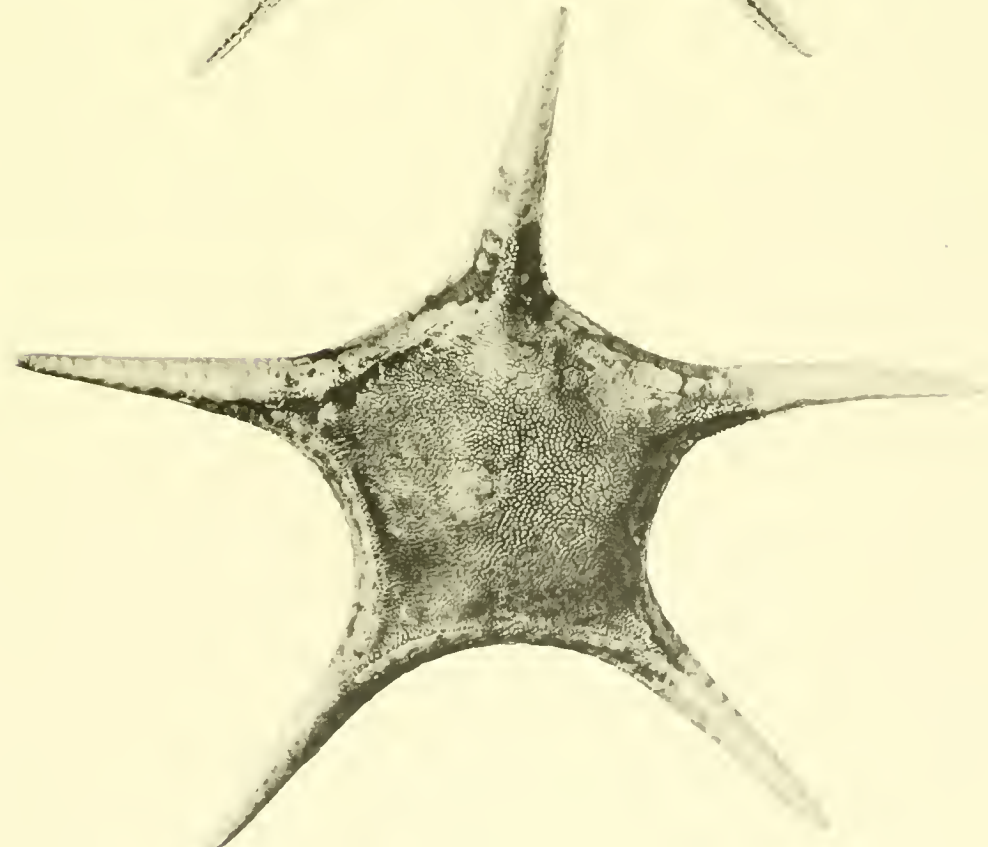
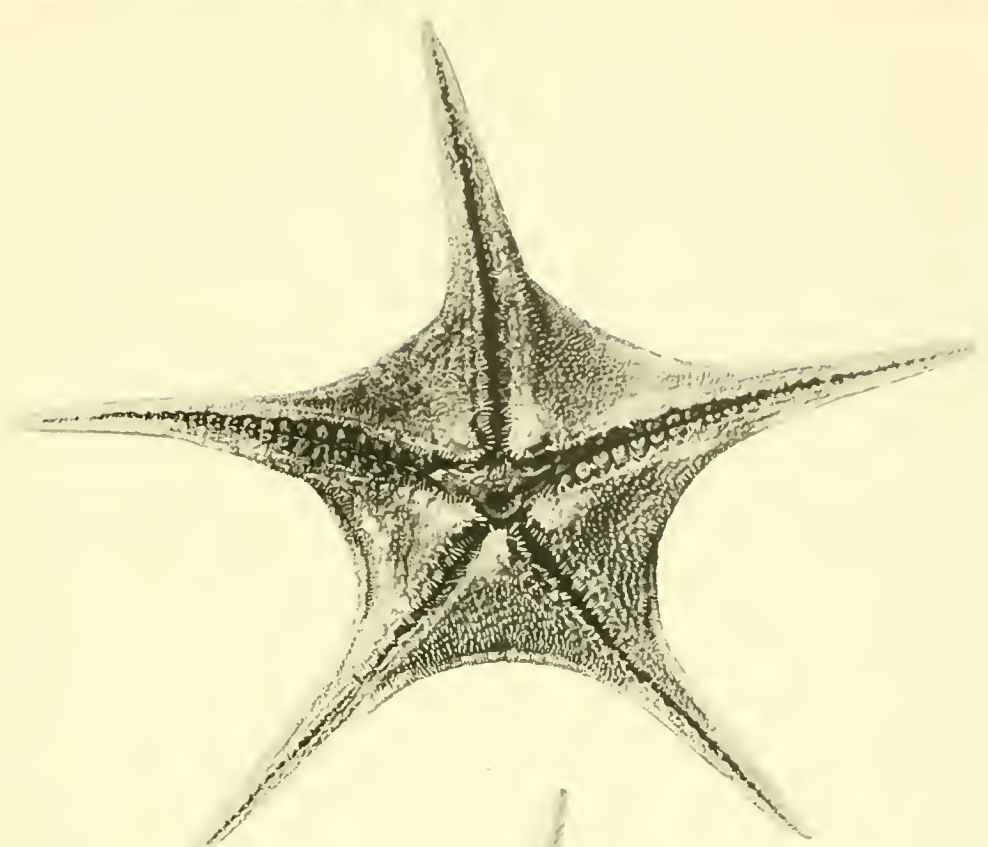


PLATE 2.

PLATE 2.

Styracaster monacanthus Ludwig. Holotype from Station 4701. $\times 2$.

1. Upper surface.
2. Lower surface.

Styracaster paucispinus Ludwig. Cotype from Station 4658. $\times 2$.

3. Upper surface.
4. Lower surface.

Albatrossia nuda (Ludwig). Holotype from Station 4647. $\times 4$.

5. Upper surface.
6. Lower surface.

Eremicaster vicinus (Ludwig). Cotype from Station 4670. $\times 2$.

7. Upper surface.
8. Lower surface.

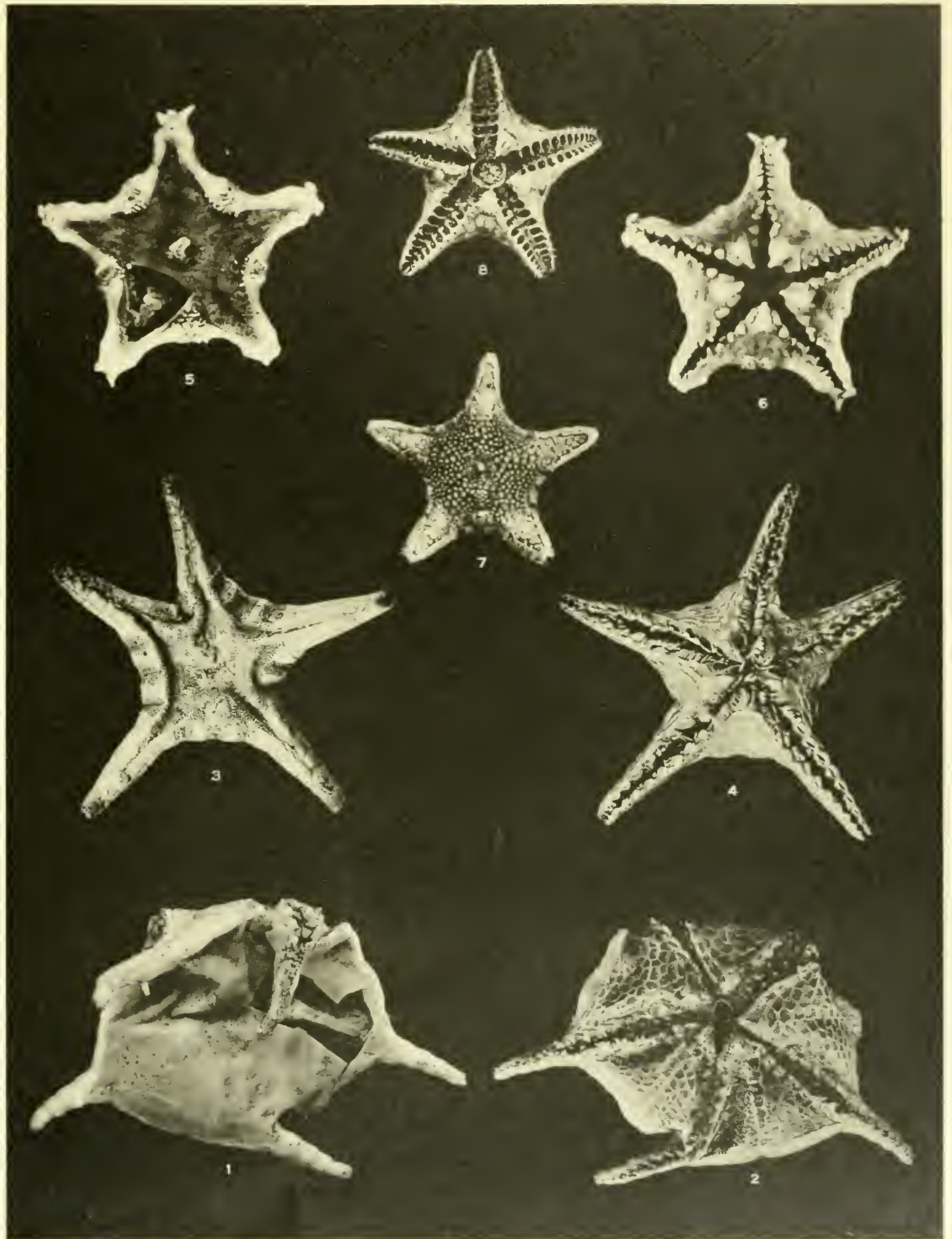


PLATE 3.

PLATE 3.

Hymenaster trias H. L. Clark. Holotype from Station 4672. $\times 2$.

1. Upper surface.
2. Lower surface.

Litonotaster tumidus H. L. Clark. Paratypes from Station 4672. $\times 2$.

3. Upper surface of a long-rayed specimen.
4. Lower surface of same.
5. Upper surface of a short-rayed specimen.
6. Lower surface of same.

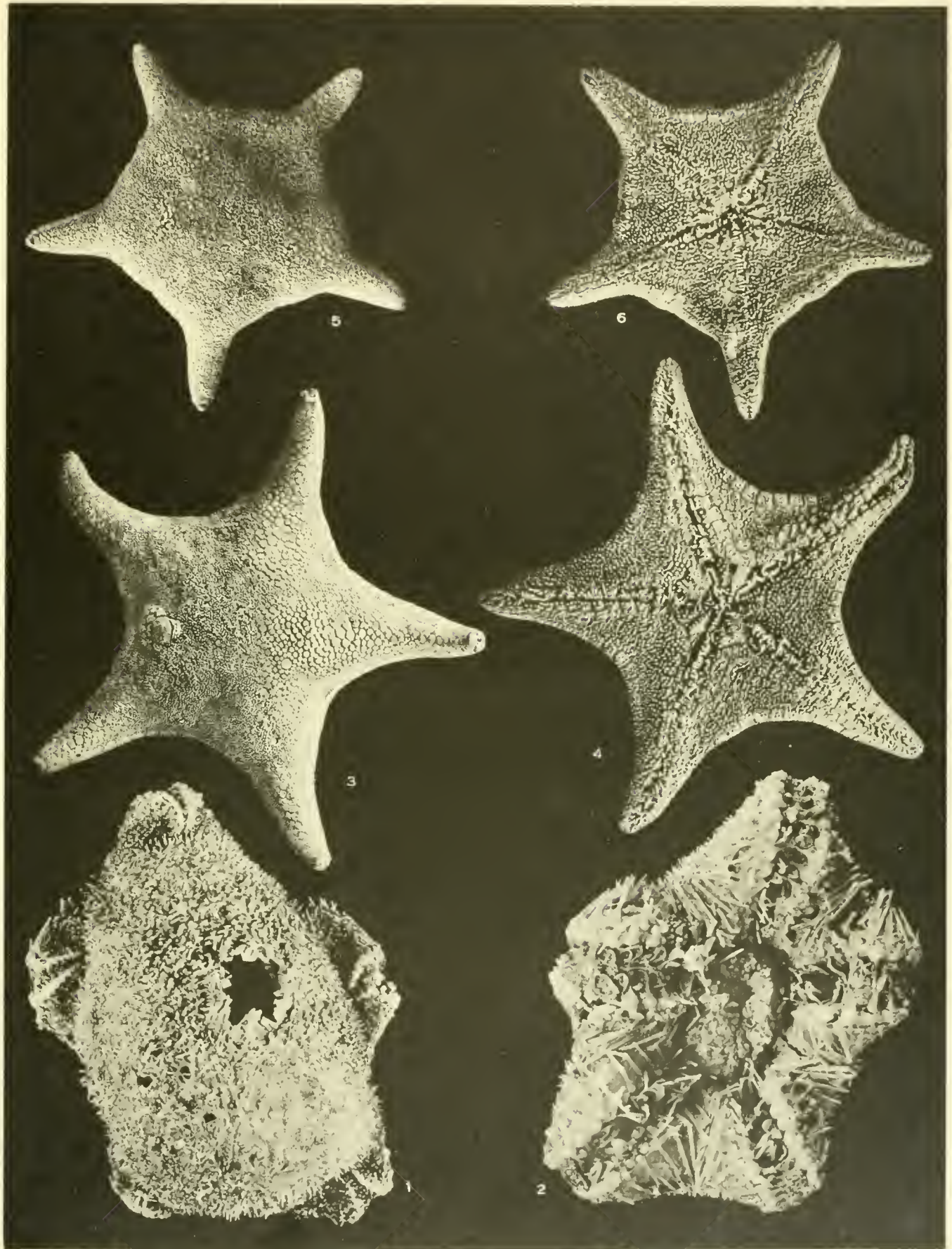


PLATE 4.

PLATE 4.

Hymenaster cremnodes H. L. Clark. Holotype from Station 4658.

1. Seen from the side. $\times 2$.

Zoroaster perarmatus H. L. Clark. Holotype from Station 4653.

2. Upper surface. Nat. size.

Stylasterias paschae H. L. Clark. Holotype from Easter Island.

3. Upper surface. Nat. size.

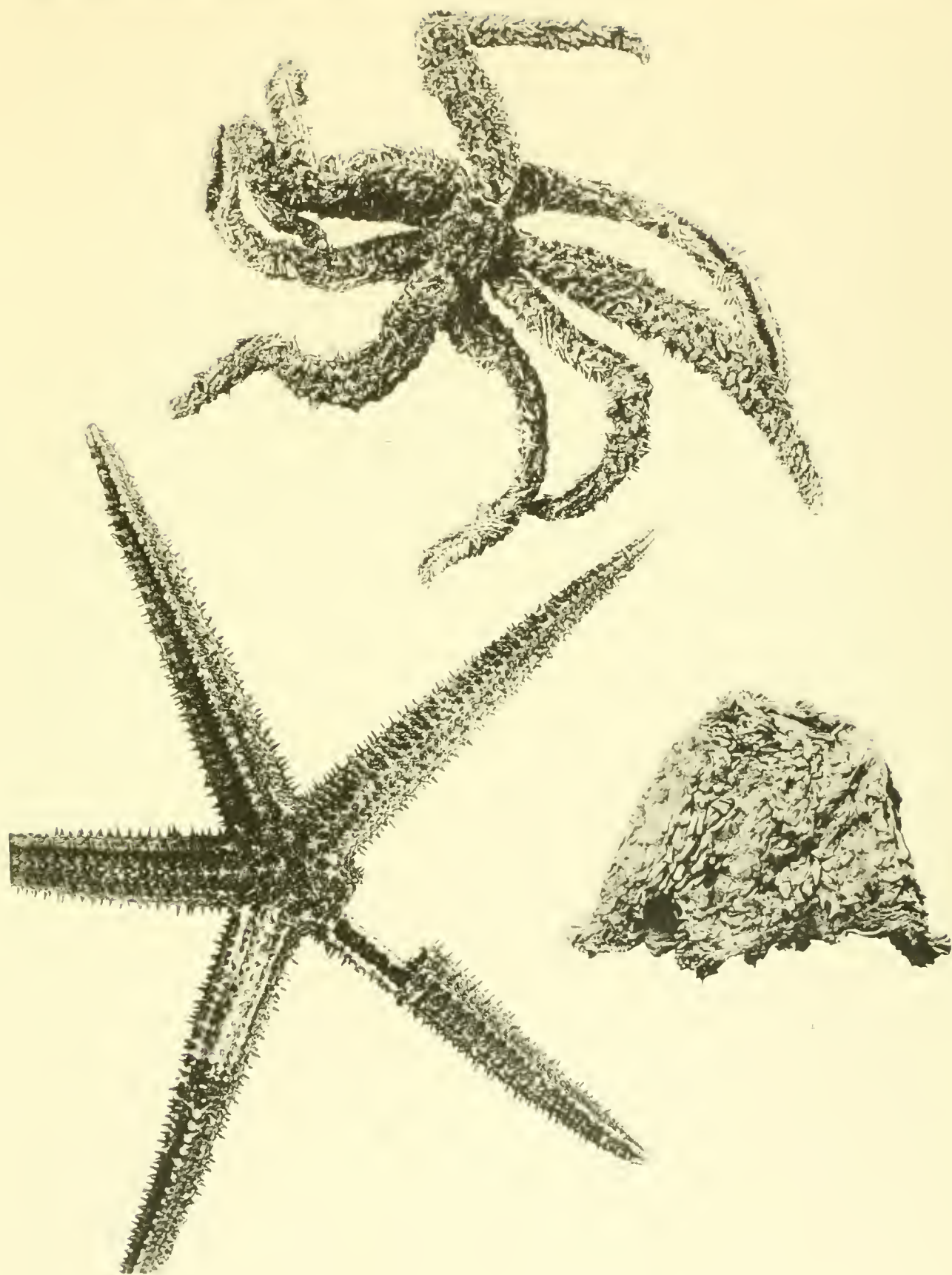


PLATE 5.

PLATE 5.

Freyellidea brevispina H. L. Clark. Holotype from Station 4740. $\times 3$.

1. Upper surface.
2. Lower surface.

Brisingella monacantha H. L. Clark. Part of ray of paratype from Station 4651. $\times 3$.

3. Lower surface.
4. Side view.

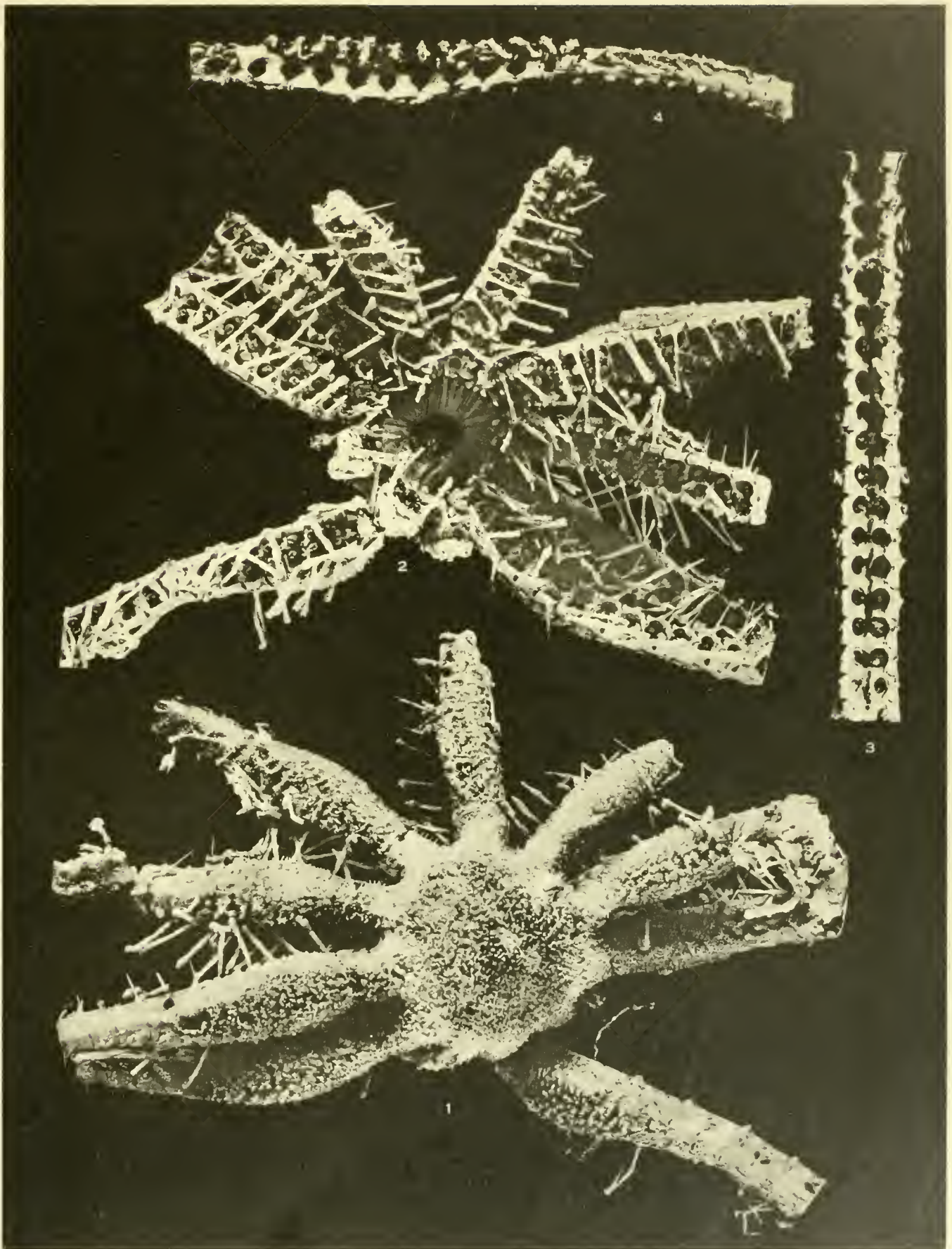


PLATE 6.

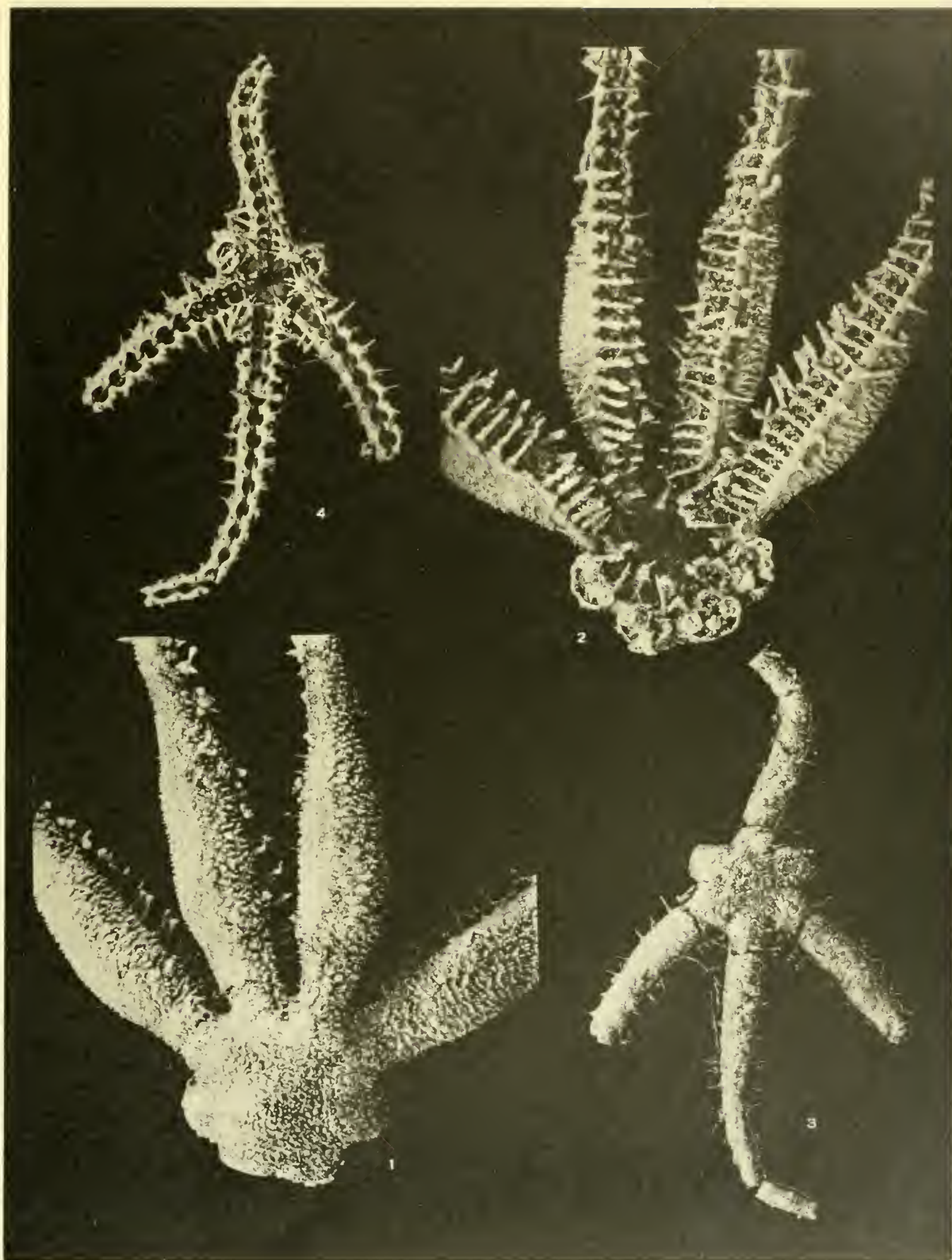
PLATE 6.

Freyellidea octoradiata H. L. Clark. Holotype from Station 4742. $\times 2$.

1. Upper surface.
2. Lower surface.

Freyellidea oligobrachia H. L. Clark. Paratype from Station 4656. $\times 3$.

3. Upper surface.
4. Lower surface.



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